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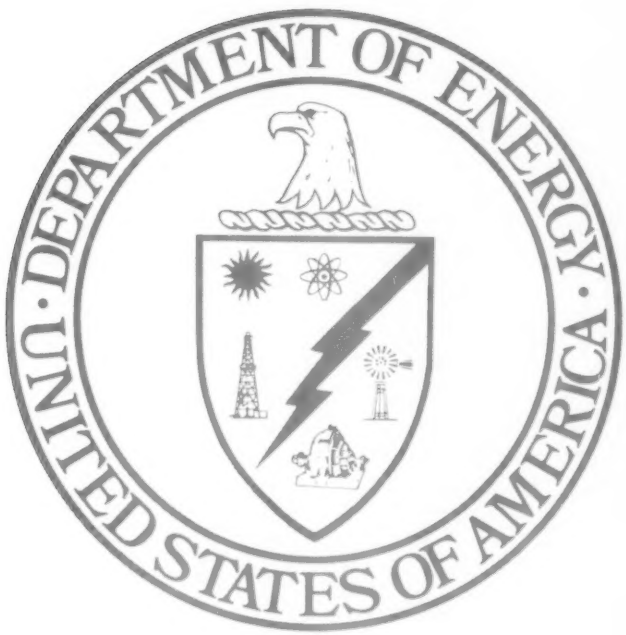

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Abey, A., *See* Schatz, J., 3:1561
Abey, A.E., Apparatus for deformation tests at intermediate strain rates—10^{-2} to 10^{-2} s^{-1}—and at high pressure, 3:1118 (UCRL-79012)
Abou-Sayed, A.S., *See* Jones, A.H., 3:202

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Volume 3, November 16, August 31, 1978

ENERGY RESEARCH ABSTRACTS

COAL AND COAL PRODUCTS

36595 (DOE/PE—0006) **Replacing oil and gas with coal and other fuels in the industrial and utility sectors.** (Executive Office of the President, Washington, D.C. (USA). Energy Policy and Planning). 2 Jun 1977. 125p. Dep. NTIS, MF A01.

Portions of document are illegible.

The impacts of programs designed to replace oil and gas with coal and other fuels in the industrial and utility sectors are described. The major provisions of the program are summarized, the overall energy impacts are identified, and the analysis for each sector which is addressed in individual sections is described. The program for replacing oil and gas has three principal elements: (1) regulatory program, (2) oil and gas conservation taxes, and (3) financial incentives. These measures differ for the industrial and utility sectors. The different time frame for the effective date of the taxes in the industrial and utility sectors reflects the greater flexibility in the industrial sector to alter current patterns of fuel consumption in the short term. The oil and gas savings which are attributable to the oil and gas replacement program are identified. The oil and gas savings of 3.3 MMB/D of oil equivalent represents a significant percentage of the oil savings from the entire National Energy Plan. Also, the savings in the industrial sector represent about two-thirds of the total 3.3 MMB/D savings from this program. (JRD)

PROCESSING

REFER ALSO TO CITATION(S) 37516

36596 **Study on increasing energy effectiveness of hard coals utilization.** Szuba, J. (Instytut Technologii Chemicznej Wegla i Ropy Naftowej Politechniki Slaskiej, Gliwice). *Koks, Smola, Gaz;* **22**: No. 9, 228-232(1977). (In Polish).

The growing energy needs of the country require a new look at coal utilization as a fuel with enhanced efficiency. The complex schemes of hard coal processing presented assure the achievement of electric and thermal energies with the highest efficiency by utilizing liquid, gaseous and solid improved fuels. The schemes secure also the needs of chemistry.

36597 **Prognosis for coal in an integrated fuel technology.** Horsfall, D. *Optima;* **26**: No. 2, 105(1976).

Since coal reserves are finite, improved extraction methods are necessary. Some of coal's more important qualities and coal consumption in South Africa are examined. Formcoke manufacture offers significant possibilities. Basic methods of converting coal into liquid fuels are discussed and fluidized bed combustion is briefly described. The coal industry could be close to having a number of technically feasible processes at its disposal that can be combined as a comprehensive approach to coal treatment called COALCOM.

CARBONIZATION

REFER ALSO TO CITATION(S) 36731

36598 **Plasticizing lean coals to render them suitable for coke-making charges.** Didenko, V.E. *Koks Khim.;* No. 6, 3-6(Jun 1977).

Three series of coking trials were carried out using untreated lean coal, coal treated with site-produced coal tar and coal treated with anthracene. There was an increase in coke yield from the anthracene batch and similarly from that treated with coal tar. The strength of the coke from the treated batches was similar to that of a standard coke. Untreated lean coal in the charge depresses the structural strength, whilst this remains unimpaired by the addition of anthracene- and coal tar-treated coal to the charges. Plasticizing in effect converts the linear structure of the lean coal into globules more amenable to the caking process involved in cokemaking.

36599 **Charge quality pattern and coking conditions and their effect on coke product and blast furnace heat parameters.** Shatolcha, I.Z. *Koks Khim.;* No. 6, 20-22(Jun 1977).

Investigation revealed that ash and sulphur variations in a coal charge and coke were almost identical and that there was a need for blending to provide a more homogenous feed for the blast furnaces. Variations in the charge coal indices are clearly reflected in strength deteriorations in the resultant coke. Temperature fluctuations in the heating flues have far less effect on strength and can even be cancelled out by blending two cokes, and variations in the coking time appear to exert little if any influence on strength. The authors suggest that coal should be stored in closed bunkers individually from each preparation plant, which should reduce fluctuations in sulphur and volatiles. Even this in their opinion will fall short of systems operating sophisticated coking practices abroad, notably Kawasaki in Japan, who have switched to big ovens and associated blending and reclaimer facilities based on a specially developed homogenizing program.

36600 **Romanian coals as a source of foundry coke.** Falk, E. *Koks Khim.;* No. 6, 25-28(Jun 1977).

Most known methods of calculating charges are for bulk charging rather than stamped. Coking trials were conducted with charges composed for the most part of Romanian gas coal which was high in sulphur and ash and had a Simonis coking index of 0.7948. Mixed with this were fat and coking coals from Czechoslovakia and the USSR with lower sulphur and ash and higher Simonis numbers. It was found that up to 30% Romanian gas coal is acceptable in conventional bulk charges. However virtually all coke in Romania, especially the newly built oven complex at Galace, is made from stamped charges. A computer program was developed with the object of finding the optimum blend ratio. The machine is supplied with reserves data, parameter fluctuation ranges, and strength target, and produces the answer for both stamped and bulk charge routes. The information obtained from this indicated that stamped charges could contain as much as 44% Romanian gas coal.

36601 **Carbonization of peat to eliminate metallic ions in aqueous solution.** Therien, N.; Boucher, J.M.; Beerli, M. *Can. J. Chem. Eng.;* **55**: No. 2, 192-196(Apr 1977).

The ionic exchange characteristics of the powdery material produced by carbonization of natural peat moss are considered. Yields of carbonized peat on a basis of calcium ion exchange capacity have been obtained for different temperatures and times in a tubular fixed bed furnace. Results indicate a crucial temperature zone for maximum exchange capacity. Exchange capacity isotherms were obtained for several metal ions and results for the regeneration of carbonized peat are reported.

36602 **Report on the activity of the Marienan experimental station in 1974 and 1975.** Foch, P.; Marcellini, R. *Ind. Miner., Mine;* No. 5, 248-260(1976).

The study of the loading of preheated charges has been an important industrial development in recent years and represents an important part of the work of the Marienan experimental station in 1974 and 1975; (a) a systematic pilot scale study of a 400 kg furnace designed on the basis of preheating charges to 250 C; (b) the industrial scale study of the loading of preheated charges in 12 furnaces in the Carling coking plant of Houilleres du Bassin de Lorraine. One notable part of the stations work was that on the measurement of the atmospheric pollution caused by coking plants as

well as the emissions from the charges in the coking plant environment.

36603 Raising coke quality standards. Zubilin, I.G. *Coke Chem., USSR (Engl. Transl.);* No. 5, 69-73(1976).

Among the measures suggested are improvement in blending of the charge; better temperature control in ovens; choice of heating regime to match the properties of the coals and the qualities required in the product; high standard of dry quenching; and crushing of +60 mm coke before screening. Improvements which should be standard practice in the near future are preheating of the charge, increasing the coking rate to 32 mm/h and upwards, greater use of dry quenching and improved crushing techniques.

36604 Ring oven for making special types of coke. Gaevskii, P.F. *Coke Chem., USSR (Engl. Transl.);* No. 4, 16-18(1976).

The gas-fired furnace is a closed annular 5m diameter tunnel with a travelling 1m wide grate. Columns between the inner and outer concrete rings carry heat-proof steel supports for the furnace lining. A system of radial beams support the service platform and the sheet steel furnace jacket is strung from these beams and columns. Heat from the combustion gases is used for differential heating of various zones. In an alternative version, the off-gas from the carbonisation stage is burned to supply the heat. Ring seals are fitted to prevent air or gas leakage. The coke product is discharged over a ramp into a receiving bunker and thence to a lower bunker where it is quenched.

36605 Coal preparation test for coking coal. Kim, Y.C.; Yang, J.I. *Chijil Kwangmul Chosa Yongu Pokoso;* **3**: 1-17(1975). (In Korean).

Since the increased energy demand interest has grown using anthracite particularly for metallurgical industrial fuel. In this connection the laboratory scale beneficiation study was conducted to produce anthracite to meet the specification of anthracite-cokes on the lower grade of anthracite produced in coal mines from Ham Tai and Chang Sung, Ok Dong and Moon Kyung, and Eun Sung which have been extensively consumed for household fuel. The beneficiation technique producing anthracite for Coke was readily attempted by Dai Han coal corporation, however, the crude material used for the purpose was high quality anthracite both in calories and other physical character, and this type anthracite is minor production of Chang Sung and Eun Sung coal mine under the corporation. Laboratory-scale experiments were also conducted with the corporation of Han Kook Coke Co. to determine the briquet strength after briquetting and calcining cokes. The result of experimental tests indicated that the anthracite can be upgraded by means of froth flotation with a remarkable recovery except coal from Moon Kyong. It was also determined by the briquetting and calcining tests that strength of the briquetting cokes was more than 93 kg/cm^2 which is amenable strength for the metallurgical fuel.

DESULFURIZATION AND PURIFICATION

REFER ALSO TO CITATION(S) 36637, 36887

36606 Process for coal desulfurization. Zavitsanos, P.D.; Bleiler, K.W. US Patent 4,076,607. 28 Feb 1978. Filed date 22 Dec 1975. 6p.

A process for coal desulfurization generates extremely low amounts of heat from microwave energy to induce thermochemical, in-situ, reactions to liberate sulfur in the form of stable gaseous species, such as H_2S, COS and SO_2.

36607 Coal desulfurization process. Dessau, R.M. (to Mobil Oil Corp.). US Patent 4,076,505. 28 Feb 1978. Filed date 22 Nov 1976. 10p.

This invention provides an improved process for reducing the pyritic sulfur content of coal, which process involves (1) contacting finely divided coal under sink-float separation conditions with a heavy organic parting medium which contains dissolved therein a dispersant quantity of a novel type of soluble sulfanilate ionic surfactant; and (2) separating a coal float phase from the liquid medium system, and recovering coal which has a lower sulfur and ash content than the untreated raw coal.

36608 Process for hydrodesulfurization and liquefaction of carbonaceous stocks using suspended catalyst. Doelp, L.C.; Friedman, L.; Mitchell, M.M. (to Air Products and Chemicals, Inc.). US Patent 4,075,082. 21 Feb 1978. Filed date 13 Aug 1976. 10p.

A solid, sulfur-containing carbonaceous feedstock, e.g., coal or other high carbon content solid, in a finely divided form is suspended in a hydrocarbon liquid along with a finely divided hydroconversion catalyst having a nominal particle size of less than about 10 microns. The resulting suspension and a hydrogen-containing gas are contacted at an elevated temperature and pressure and at a weight hourly space velocity of between 200 and 50,000 kg of the suspension per kg of catalyst per hour. The resulting product is continuously withdrawn from the contact zone and normally gaseous materials are separated. A liquid product having a substantially reduced sulfur content and containing the finely divided catalyst is recovered as desulfurized product.

36609 Method of removing sulfur from coal. Sinke, G.C. (to Dow Chemical Co.). US Patent 4,071,328. 31 Jan 1978. Filed date 22 Jan 1976. 6p.

A process of reducing the total sulfur content of coal is disclosed. The process comprises hydrogenating the coal to remove at least a portion of the recoverable sulfur combined as pyritic sulfur. The hydrogenated coal is subsequently contacted with a sufficient amount of an aqueous inorganic acid solution to remove at least a portion of the remaining sulfur initially combined as pyritic sulfur.

36610 Desulphurization of coal with ozone: an attempt. Steinberg, M.; Yang, R.T.; Hom, T.K.; Berlad, A.L. *Fuel;* **56**: No. 2, 227-228(Apr 1977).

When coal was treated with ozone in oxygen, an increase in sulfur in the effluent gas was measured. Preliminary results of this study are reported. The process could not serve as a basis for a coal desulfurization process unless the amount of sulfur removed could be increased significantly. Since no nitrogen oxides were found in the effluent gas, it is doubtful that denitrification could be accomplished by ozonization.

HYDROGENATION

REFER ALSO TO CITATION(S) 36608, 36645

36611 Effect of hydrogen pressure on the hydrogenation reaction of coal. Maekawa, Y. *J. Chem. Eng. Jpn.;* **10**: No. 2, 101-103(Apr 1977).

The hydrogenation of Sumiyoshi coal was studied at 400°C under the reaction pressure of 110 to 220 atm. The reaction rate constant was calculated from the rate of decrease of unreacted coal. The data obtained were expressed as a first order reaction consisting of two steps. The rate constant in the second step increased linearly with hydrogen pressure, but the rate constant of the direct production of oil from coal in the first step was almost constant.

36612 Hydrogenation of hard coals. Hodek, W.; Kuehn, L. *Erdoel Kohle, Erdgas, Petrochem.;* **30**: No. 2, 85(Feb 1977).

Paper discusses the influence of minerals in coal, particularly pyrite, on hydrogenation.

GASIFICATION

REFER ALSO TO CITATION(S) 36642, 36646, 36704, 37042, 37232, 37233, 37237, 37893

36613 (CONF-770440—, pp 2-8) **Coal resources for in situ gasification.** Glass, G.B. (Wyoming Geological Survey, Laramie). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

In situ gasification offers recovery potential for an otherwise unrecoverable portion of the nation's coal resources. Although precise criteria for estimating in situ resources are not yet established, a first order approximation is more than three trillion tons. Seventy percent of these resources are located in coal fields of the Rocky Mountain region. The remainder is about equally divided between the eastern, midcontinent and far western fields. This approximation excludes strippable resources because subsidence and possible leakage associated with in situ recovery of these shallow resources makes their use doubtful. In practice, however, other factors will further reduce this in situ resource estimate. These factors include coal thickness, coal quality, coal and cover permeability, maximum depth of burial, partings, deposit size, faults, enclosing rocks, hydrologic and land surface conditions.

36614 (CONF-770440—, pp 9-19) **Assessment of in situ coal gasification.** Stoller, H.M. (Sandia Labs., Albuquerque, NM); Brandenburg, C.F.; Northrop, D.A. 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

Since 1973, ERDA and its predecessor agencies have been conducting field experiments, laboratory investigations and analytical studies on in situ coal gasification. While the U.S. development of this technology is still in an early stage, a significant amount of information is becoming available by which to assess the technical feasibility, economic viability and environmental impact of this approach to coal resource utilization. This paper will discuss, based on available information, such factors as resource applicability, resource utilization, process products and economics, environmental impact, and health, safety and societal aspects. The overall conclusion is that

current results are extremely encouraging and an accelerated development of this technology is warranted.

36615 (CONF-770440—, pp 20-27) **Technical and environmental factors in underground coal gasification.** Edgar, T.F.; Humenick, M.J.; Kaiser, W.R. (Univ. of Texas, Austin). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977). In Energy and mineral resource recovery.

Underground coal gasification is a process which should be considered as a competitor on an economic basis with shaft mining of coal. However, given present technology, not all coal seams and locations are viable candidates for the application of this technology. The important parameters in technical site selection, including engineering and environmental aspects, will be delineated. A discussion of the effects of coal properties, geological conditions, and operating parameters on underground coal gasification will be given.

36616 (CONF-770440—, pp 28-43) **Will underground coal gasification ever be commercialized in the USA.** Arscott, R.L.; Garon, A.M. (Gulf Research and Development Co., Pittsburgh). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977). In Energy and mineral resource recovery.

The title question is premature so the only sensible answer at this time is maybe. The correct answer involves undefined technical, environmental and political factors which will affect the economics of this technology and that of competitive energy sources. It is clear, however, that the combination of the worsening natural gas supply situation, the abundance of coal in the U.S., the inherent advantages of gaseous fuels, and the lower environmental impact of in situ processes over mining will all contribute toward future commercialization of underground coal gasification. This paper analyzes the cost of the underground process and the market options for utilization of the products. There are two main options in the operation of the underground process; one is to use air and the other is to use oxygen. An air blown process will produce a low-heating-value gas which could be used for process heat or to generate electricity. The overriding factor in this option is that the gas must be used very close to the wellhead or transmission costs will become excessive. If oxygen and steam are used as gasifying reagents, the resulting gas can be used as a synthesis gas for the manufacture of substitute natural gas (SNG) or other products such as methanol or ammonia. The market for SNG is enormous and is the best option for in situ produced gas. The main competition is SNG produced from a surface gasifier using mined coal. Depending on the assumptions used, the cost of SNG from an underground process ranges between 50 percent and 120 percent of the cost of SNG from a surface Lurgi gasifier using similar economic criteria. The costs of producing and marketing low-heating-value gas for industrial process steam are examined. Similarly, the costs and marketing factors associated with synthesis gas for chemical feedstocks such as methanol and ammonia are analyzed.

36617 (CONF-770440—, pp 158-174) **ERDA's national program for underground coal gasification.** Wieber, P.R. (Energy Research and Development Administration, Washington, DC). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977). In Energy and mineral resource recovery.

This paper presents the underground coal gasification program of the United States Energy Research and Development Administration (ERDA). This technology can expand the usable United States coal resources and potentially reduce plant investment, gas costs, and environmental impacts, compared with mining plus surface gasification. The present status of four major projects is reviewed. The Linked Vertical Wells concept is in the furthest stage of development, and it will have increased emphasis in the future. The other three projects are exploring alternative linking and gasification schemes for processing a wider range of coal resources at many geographic locations. Possible test sequences are presented for the following options: scaleup of LVW; proof of wide site applicability for LVW; development of steam/oxygen gasification; explosive-fracture concepts; thinner eastern coals of low permeability; and steeply dipping seams. Commercial application of low- and medium-Btu first generation processes could occur by the mid-1980's.

36618 (CONF-770440—, pp 175) **Linked vertical well concept for UCG.** Brandenburg, C.F.; Fischer, D.D. (Laramie Energy Research Center, WY). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977). In Energy and mineral resource recovery.

Recent field tests of underground coal gasification in the United States have led to a greater degree of optimism for the eventual commercialization of this technique due in part to a more complete understanding of the process itself. The most recent test at Hanna, Wyoming, has demonstrated that a high quality low Btu gas can be predictably produced for long periods and that process control techniques can be utilized. Furthermore, with proper site selection the performance of the underground reactor can equal if not exceed that of an air blown surface gasification system. Recent tests have demonstrated cold gas efficiencies of 85 percent and energy return ratio of 5:1. Most important to an efficient process is an explanation of this high performance. Results show that the key determinant of high efficiency is the inherent nature of thick seams of coal which shrink and become friable when heated. These properties allow for a process which provides a self-propagating mechanism for a packed bed to achieve the intimate contact between the reactants necessary for optimum gasification conditions.

36619 (CONF-770440—, pp 176-189) **Preliminary results from an in-situ coal gasification experiment using explosive fracturing.** Thorsness, C.B.; Hill, R.W.; Stephens, D.R. (Univ. of California, Livermore). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977). In Energy and mineral resource recovery.

The approach to in situ coal gasification originated at LLL utilizes an array of chemical explosives to enhance the permeability of a reaction zone within a thick bed of coal. In this paper we describe results from the first field test of this concept, the Packed Bed Process. Experiment No. 1 was a simple two-spot fracturing experiment that was carried out at Hoe Creek, Wyoming. It consisted of two explosive charges fired simultaneously at the bottom of a coal seam. Pre and post fracture characterization of the site show that the coal permeability was stimulated from 0.3 darcy preshot to about 2 to 4 darcies postshot. Examination of cores taken after the blast showed moderate to heavy fracturing in the upper few feet of the coal bed, then a lesser fractured zone in the middle, and a highly pulverized zone at the bottom 5 to 10′ of the coal bed. Correspondence of the degree of fracturing with code calculations is building confidence in our ability to calculate the extent of fracturing. However, a review of flow behavior has led to the conclusion that permeability is not a simple function of the degree of fracturing. On October 15, 1976 the coal was ignited and gasification proceeded for 11 days. During this time, 130 tons of coal was gasified out of an estimated 1000 tons of coal within the fractured region. Heating quality of the gas averaged 110 to 150 Btu/scf.

36620 (CONF-770440—, pp 190-196) **Underground gasification of bituminous coals.** Martin, J.W.; Strickland, L.D.; Schrider, L.A. (Energy Research and Development Administration, Morgantown, WV). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977). In Energy and mineral resource recovery.

Insufficient technology exists to advance any one process for the recovery of eastern bituminous coals in situ. The applicability of the LVW technology will be evaluated in MERC's first field test; and, simultaneously, valuable data will be obtained to facilitate engineering design of the second field test. Final plans for Pricetown II will be completed when information from the modeling, laboratory, and Pricetown I efforts have been studied.

36621 (CONF-770440—, pp 197-201) **Alberta UCG field test, 1976.** Roehl, A.A.; Brown, R.A.S.; Jensen, E.J. (Alberta Research Council, Edmonton). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977). In Energy and mineral resource recovery.

The Alberta Research Council operated a field test of underground coal gasification at Forestburg, Alberta, during the summer of 1976. During the test about 300 tons of coal were gasified from a 12-foot seam of subbituminous coal under 60 feet of overburden. Linking was carried out by reverse combustion. Water for the reaction was obtained naturally from groundwater and no water was injected. Fuel gas having a heating value up to 150 Btu/ft^3 was produced. Plans for post-test evaluation of the reaction zone are currently being formulated. The design and operation of the gasification test are discussed.

36622 (CONF-770440—, pp 208-220) **In situ gasification of steeply dipping coal beds.** Rupert, R.C. (TRW Defense and Space Systems Group, Redondo Beach, CA). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977). In Energy and mineral resource recovery.

The configuration and operation of the special case of in situ gasification of steeply dipping coal beds are described. Alternate configurations and single and multiple module operational aspects are discussed. The various usages of the end product as fuel, as chemical feedstock and as a source of sensible heat are noted. A review of the applicable coal resources is given, covering location, quantity estimates, geological factors and market proximity. Also

discussed are major site selection criteria such as the preferred physical and chemical properties of the coal, the desired coal bed characteristics and associated topography and geology of the area, plus certain other logistic considerations and environmental concerns. The possible engineering problems are covered including roof fall, plugging, subsidence, extraction ratio, drilling, leakage, process stability, process control, process efficiency and fire control. The potential advantages that underground gasification of steeply dipping coal beds seems to have over other in situ concepts are pointed out. These include better drilling efficiency, higher overall extraction ratio, better process stability, and minimal environmental impact. Some economic background is reviewed and the possible economic advantage of the steeply dipping bed concept is outlined.

36623 (CONF-770440—, pp 308-315) **Underground lignite gasification at Texas A and M University.** Jennings, J.W.; Strickland, R.F.; Von Gonten, W.D. (Texas A and M Univ., College Station). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

During the past three years laboratory studies have been conducted on Texas lignite to determine combustion and gasification products as a function of pressure and temperature. More recently, the scope of the program has been expanded to include mathematical modeling and field testing. A numerical model has been developed which predicts gas compostion and flame front velocity. The model has been validated by simulation of laboratory combustion tube experiments on Texas lignite. The model and laboratory experiments were used to design a field test on underground lignite gasification in the Yegua formation in Brazos County, Texas. In addition, the model has been used to make parametric studies. This paper presents a summary of the results of the studies mentioned above, the current status of the project, and an outline of work to be completed in the near future including details of the field test.

36624 (CONF-770440—, pp 316-317) **Kentucky's program for underground coal gasification for thin seams.** Hahn, O.J.; Debrand, S. (Univ. of Kentucky, Lexington). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

Underground gasification concepts in the past have relied on a positive containment of the gasification area by the overburden and the ground water. A gasification concept is proposed for thin and/or sloping seams above the groundwater table. The Appalachian coal fields contain a number of thin coal seams (below 20 inches) which can, at present, be only mined by strip mine techniques. The gasification concept relies on negative pressure in the gasification zone and controlled air access. The gasification pathways are bored by a machine similar to today's auger miner. These pathways are envisioned to contain baffles for air flow control. This system will permit, if successful, the recovery of up to 50 percent of coal by auger mining techniques and up to 30 percent by gasification. Measurements have indicated that the permeability after auger mining is increased to about 10 darcies. Laboratory gasification tests in a quartz tube and simulated auger holes have given satisfactory gasification rates at 600 to 1000°C. Further laboratory tests are in progress.

36625 (CONF-770440—, pp 318-331) **Significance of natural aquifers in underground coal gasification.** Gunn, R.C. (Univ. of Wyoming, Laramie); Fischer, D.D.; Whitman, D.L. 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

A mathematical theory of in situ coal gasification has been developed and validated with results from three extensively instrumented field tests conducted at Hanna, Wyoming. The mathematical model predicts gas compositions, coal and water consumption rates, gas production rates, gas heating values, and temperature and composition profiles. A comparison of calculated and experimental results are reported here for the Phase III, Hanna II test. Agreement is good. Predicted gas compositions are accurate to within 1 to 2 percent on the average. Calculated gas flow rates and heating values are also accurate to within a few percent. The steam-carbon and water gas shift reactions are important contributors to the heating value of gas produced by in situ coal gasification. It is somewhat surprising, therefore, that water influx from natural aquifers is a major UCG (Underground Coal Gasification) problem. The Phase III field test was unlike previous Hanna experiments because a high influx of water caused the experimental results to deteriorate throughout the latter part of the test. The mathematical model correctly predicts these results and provides a theoretical explanation for them.

36626 (CONF-770440—, pp 332-344) **Structural mechanics and model simulations associated with underground coal gasification.** Advani, S.H.; Lin, Y.T.; Shah, V.; Wang, H.F. (West Virginia Univ., Morgantown). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

The extensive interest in underground gasification of Eastern United States coal ensues from the 1974 energy crisis and the resulting need for maximizing coal energy recovery. The primary technical problems for successful gasification from a structural standpoint are (i) ground subsidence and cavity roof collapse and (ii) plugging of coal fissures and combustion channels due to the bituminous coal swelling at elevated temperatures. This paper details the temperature, stress, and displacement profiles associated with underground coal gasification. Finite element model results illustrating stable roof configurations are also given. Models illustrating coal thermal cracking, softening/swelling/plugging, channeling, and flame front stability are presented for forward combustion and linking by reverse combustion. Selected results from laboratory model simulations conducted by the Morgantown Energy Research Center, ERDA are discussed within the framework of these analytical models. Result applications to field tests using either the Vertical Well to Vertical Well Linking Concept or the Longwall Generator Concept are given Combustion configurations and paths are identified from a stress vantage point.

36627 (CONF-770440—, pp 654-662) **Calculational modeling of explosive fracture and permeability enhancement.** Butkovich, T.R.; Burton, D.E.; Bryan, J.B. (Univ. of California, Livermore). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

With its underground explosion computer codes SOC and TENSOR, the Lawrence Livermore Laboratory is developing a capability for computer code prediction of fracture intensity and permeability enhancement far from a free face. Because the codes calculate fracture and not permeability, one must relate experimental measurements to a calculable parameter for fracture. High-explosive experiments in a coal outcrop and a multiple-charge experiment in a coal seam were designed to provide the needed data. Fracture intensity observed around the explosion centers is shown to be related to a calculated damage parameter $\epsilon/\text{sub f}/$. This parameter is actually the total failure-induced deviatoric strain. Intrinsic permeability, determined from hydraulic conductivity and calculated from results from slug tests in wells near the explosion, correlates at least qualitatively with the calculated residual tensile-fracture porosity, $\pi/\text{sub f}/$. An important observation is that no tensile failure occurs for some distance from the explosion-formed cavity when spherical charges are employed, whereas, tensile failure occurs near the cavity wall when cylindrical charges are used.

36628 (CONF-771092—4) **Status of the HYGAS program.** Bair, W.G. (Institute of Gas Technology, Chicago, Ill. (USA)). 1977. Contract EY-76-C-02-2907. 14p. Dep. NTIS, PC A02/MF A01.

From 9. synthetic pipeline gas symposium; Chicago, IL, USA (31 Oct 1977).

The past year has been one of accelerated activity for the HYGAS Pilot Plant developmental/experimental program. This paper will summarize these activities and discuss future plans. Major achievements during the past year included: (1) Successful long-term operation of the HYGAS Pilot Plant with Montana subbituminous coal from the Rosebud seam; (2) Initiation of tests with agglomerating bituminous coal from the Illinois Basin. The purpose of these tests is to determine the operating conditions necessary to achieve high coal conversion in the HYGAS gasifier and to determine the maximum capacity of the gasifier. Successful operation has been demonstrated at 85 percent coal conversion; (3) Initiation of a program to provide direct engineering support for the United States Energy Research and Development Administration (now the Department of Energy) project (with Procon, Inc.) for the design of a commercial/demonstration plant based on the HYGAS Process; (4) Installation and provision of operating support for the Liquid Phase Methanation pilot unit now installed in the HYGAS Pilot Plant. Chem Systems, Inc., is responsible for the technical direction of this program and direction of operations. The Institute of Gas Technology is providing a test site, operations support, and maintenance and construction support activities.

36629 (CONF-7706107—, pp 34-37) **Coal gasification now.** Mermer, N.F. (ANG Coal Gasification Co., Detroit). 1977.

From 73. meeting of the Rocky Mountain Coal Mining Institute; Vail, CO, USA (26 Jun 1977).

In Proceedings of the seventy-third regular meeting of the Rocky Mountain Coal Mining Institute.

Every conceivable energy source is needed and will help, but over the next few decades, domestic increases in Btu production will be geared heavily to fossil fuel production in the form of coal, gas and oil including production of oil and gas from shales and other low permeability strata. Coal will be needed for direct use, it will be

needed for conversion into fuels that can be consumed by existing gas and oil burning equipment, and for the generation of electricity. I endorse and support all efforts toward the development of renewable resources, such as, wind, bio-mass, solar energy and fusion, but the present timetable for projected development and level of contribution is unrealistic. Against this backdrop of uncertainty new energy source availability and the need therefore, I would like to talk about our project in Mercer County, North Dakota, which will be one of the first in the United States. Notwithstanding the disappointments and frustrations caused by delay, we continue to press forward with our efforts holding firmly to the conviction that coal-derived synthetic gas projects are desperately needed and will eventually be constructed. We feel there is virtually no risk on the technology and are optimistic that permits and environmental approvals will be granted in accordance with our timetable which calls for field activity to commence in 1978 and plant start-up in late 1981. The 1600 acre plant site has been optioned, we of course have the coal and the water and engineering design along with material specifications are continuing at a planned but rapid pace. A great deal of effort is being expended in the area of community planning that will allow the coordination of methods by which socio-economic impact can be ameliorated. Financing is the remaining critical issue.

36630 (FE—2240-83) **Quarterly technical progress report for the period January—March, 1978.** Detman, R. (Braun (C.F.) and Co., Alhambra, Calif. (USA)). Apr 1978. Contract EX-76-C-01-2240. 14p. Dep. NTIS, PC A02/MF A01.

36631 (FE—2275-5) **Systems studies of coal conversion processes using a reference simulator. Quarterly report, July 1, 1977—September 30, 1977.** Reklaitis, G.V.; Sood, M.K.; Raghavan, S.; Overturf, B.W.; Fazzoni, G.F.; Ford, J.R. (Purdue Univ., Lafayette, Ind. (USA)). Nov 1977. Contract EX-76-C-01-2275. 93p. Dep. NTIS, PC A05/MF A01.

The objectives of this study are to develop a conceptual flowsheet of a coal conversion plant which will process Illinois No. 6 coal and will employ the basic processing sequence proposed by the Illinois Coal Gasification Group. The conceptual flowsheet differs from the ICGG proposal in that proprietary or otherwise ill-defined processing steps are replaced with units whose operating data is adequately reported in the open literature and for which satisfactory design models can be formulated. The purpose for formulating this flowsheet is to define a base case conceptual process which will be modelled using both the steady state process simulation package being developed for DOE/FE under our current contract as well as the dynamic simulation library being developed by Lehigh University under a separate contract. Key elements in the process are described.

36632 (FE—2286-16) **Preparation of a coal conversion systems technical data book. Project 8979 annual report, May 1, 1976—April 30, 1977.** (Institute of Gas Technology, Chicago, Ill. (USA)). Jan 1978. Contract EX-76-C-01-2286. 678p. Dep. NTIS, PC A99/MF A01.

In this report we have presented solubility data on binary mixtures of gases, water, and oils (hydrocarbon liquids) and vapor-liquid equilibria in the NH_3-H_2S-CO_2-H_2O system over the temperature range of 68° to 300°F are discussed. Various correlations for estimating calorific value of coal are evaluated and occurrence of trace elements in coal is tabulated. Summaries of coal-liquid properties are presented covering the following areas: Chemical, Physical, and Biological Properties of Coal Liquids; Effect of Aging on Properties of Coal Liquids; Combustion Properties of Coal Liquids; and Properties of Upgraded Coal Liquids. Current practices for sampling, storing, and handling coal are described. Various coal preparation procedures are outlined. Design charts are presented for gasification of char in a fluidized bed with steam and air at 1, 15, and 70 atmospheres pressure, at temperatures of 1750°, 1800°, 1850°, or 1900°F, at various steam-to-carbon feed ratios. Sulfur retention capability of limestone and dolomite in fluidized-bed combustion is described. Gas-solids upflow in inclined pipes is discussed. Gas-solids downflow in fluidized-flow regime is reviewed. Heat transfer correlations for fluidized-bed combustors are reviewed in detail. Federal environmental regulations, as well as those for Illinois and New Mexico, are discussed and various stack-gas cleaning processes are described. This abstract mentions only a part of the information in the report.

36633 **Process for obtaining liquid fuel-oil and/or gaseous hydrocarbons from solid carbonaceous feed stocks.** Hollaway, J.W. (to Rio Tinto (Rhodesia) Ltd.). US Patent 4,076,612. 28 Feb 1978. Priority date 7 Dec 1973, South Africa. 6p.

A process for forming a fuel-oil from coal is disclosed. The coal is treated in a low temperature carbonization retort to give coke, coal-gas and tar-oil. The coke is converted to water-gas which is then synthesized in a Fischer-Tropsch synthesizer to form fuel-oil. The tar-oil is hydrogenated in a hydro-treater by hydrogen produced from the coal-gas. Hydrogen is produced from coal-gas either in a thermal cracking chamber or by reforming the methane content to hydrogen and passing the resultant hydrogen/carbon monoxide mixture through a water-gas shift reactor and a carbon dioxide scrubber.

36634 **Process of gasifying solid fuels, particularly coal.** Hafke, C.; Kohlen, R. (to Metallgesellschaft Aktiengesellschaft). US Patent 4,071,332. 31 Jan 1978. Priority date 26 Feb 1976, German, Federal Republic of (F.R. Germany). 4p.

In a process of gasifying solid fuel such as coal comprising the steps of contacting the solid fuel under a pressure of at least about 5 bars in a reaction chamber surrounded by a water-cooled zone, the reaction heat eevaporating water in said zone, transferring the water vapor from said zone to the reaction chamber, removing product gas from the reaction chamber, scrubbing and cooling said product gas in a scrubber-cooler, and periodically interrupting normal gasification, the improvement which comprises discontinuing the transfer of water vapor to the reaction chamber during such periods of other than normal gasification and instead transferring the water vapor to said scrubber-cooler, whereby generation of product gas will be discontinued during such periods. Hot steam may be supplied to the water-cooled zone during said periods of interruption to delay a drop in the temperature of the fuel in the reactor chamber so that upon resumption of normal operation the initially produced gas will be of substantially normal composition.

36635 **Coal gasification plant.** Eales, D.F. (to British Gas Corp.). US Patent 4,071,329. 31 Jan 1978. Priority date 27 Nov 1975, United Kingdom of Great Britain and Northern Ireland (UK). 6p.

The quench chamber of a slagging pressure gasifier is provided with a perforated tubular air ring remote from the slag tap main burner of the gasifier and arranged, in use, to supply the burner with a secondary air supply and, at the same time, so set up an air circulation adjacent the walls of the chamber above the normal water level therein, thereby to cool the walls. There is further provided a nozzle mixing ring burner for use in a slagging gasifier comprising a body having two integrally formed chambers each having respectively a gas inlet and outlet and an air/oxygen inlet and outlet. The outlets are directed toward a shaped annular portion on the inner periphery of the ring body.

36636 **U.S. examines British gas from coal process.** *Coal, Gold Base Miner. South. Afr.;* **25**: No. 4, 75-77(Apr 1977).

Brief details are given of the present stage in the development of the British Gas slagging gasifier.

36637 **Koppers—Totzek coal gasification process.** Leonard, H.F.; Macdonald, S. *ISM;* **3**: No. 10, 23-29(Oct 1976).

The Koppers-Totzek gasification process is described. The gas obtained contains 53-59% carbon monoxide, 31-36% hydrogen, and 10% carbon dioxide, depending on the quality of the coal. After removal of the carbon dioxide and sulphur, it can be used for direct reduction of iron.

LIQUEFACTION

REFER ALSO TO CITATION(S) 36608, 36631, 36632, 36633, 36651, 37551

36638 (CONF-770440—, pp 345-355) **Structural, mechanical, and chemical factors affecting coal liquefaction and their relationship to in-situ liquefaction of coal.** Murr, L.E.; Brower, K.R.; Wongwiwat, K. (New Mexico Inst. of Mining and Technology, Socorro). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

Laboratory studies of a total of 17 coals (primarily subbituminous) and ranging in occurrence from surface coals to 2500 ft deep seams have indicated that the physical structure of coal, while it varies somewhat with depth, does not have a measurable influence on the ability of the coal to be liquefied by solvent extraction methods. High sulfur content is demonstrated by observations in the scanning electron microscope to be characterized primarily by pyritic inclusions, but there was no correlation of sulfur content with depth of occurrence. A correlation was observed between coal surface hardness and depth, with hardness generally increasing with increasing depth. Similarly, liquefaction yield by solvent extraction (primarily with tetralin) was shown to increase with an increase in carbon content (in the range 43-83 percent C), while the hardness was shown to increase correspondingly with an increase in carbon content. Liquefaction yield by solvent extraction was also shown to be significantly influenced by oxygen content, increasing with a decrease in oxygen content. The oxygen content was also observed to decrease with increasing depth of occurrence. By comparison, liquefaction yield by hydrogenation was observed to be essentially constant and independent of either carbon or oxygen

content in the range of samples investigated. These results seem to indicate, perhaps somewhat fortunately, that the deeper coal seams would tend to be more readily liquefied by solvent extraction methods. The requisite conditions for fluid retention and pressure sealing are discussed in the context of in-situ liquefaction of deep coal seams by solvent extraction methods, and the ability to form and propagate cracks in a deep-seam coal structure as it may be influenced by the physical and mechanical properties of the coal is discussed in relation to the direct observations of coal structure made in this investigation by scanning electron microscopy.

36639 (FE—1743-45) **Zinc halide hydrocracking process for distillate fuels from coal. Quarterly technical progress report, August 1—October 31, 1977.** Parker, W.A.; Maskew, J.T.; Zielke, C.W.; Pell, M.; Struck, R.T. (Conoco Coal Development Co., Library, Pa. (USA). Research Div.). 20 Nov 1977. Contract EX-76-C-01-1743. 107p. Dep. NTIS, PC A06/MF A01.

Construction of the 100 lb/hr PDU continued on schedule. Operator pressure testing of the first two sections will begin November 1. Completion of the Regeneration Section (and the plant) is now scheduled for April 30, 1978. The continuous bench-scale hydrocracker program has been completed except for one run. The results have been correlated by a first-order model which fits the data well. This correlation and yield correlations are reported herein for Colstrip subbituminous coal liquefied at 385 to 413°C and 13.8 to 20.6 MPa (2000 to 3000 psig) of hydrogen. The first attempt to dry and grind the subbituminous coal for PDU use produced a fine grind with low moisture, but its reactivity suffered during the drying step. Further tests are planned. An economic study has been completed showing a saving of 3 cents/gallon gasoline if secondary recovery of zinc from effluent ash is used.

36640 (FE—2251-50) **Conceptual design for advanced coal liquefaction commercial plant. Technical report for the month of March 1978.** (Fluor Engineers and Constructors, Inc., Irvine, Calif. (USA)). Apr 1978. Contract EX-76-C-01-2251. 33p. Dep. NTIS, PC A03/MF A01.

Continuing effort on this contract consists of additional studies as follows: (1) Evaluate whether catalytic cracking should be used in the refining sequence in the conversion of coal to gasoline. The base case in the Advanced Coal Liquefaction configuration employs hydrocracking and excludes the catalytic cracking step. (2) Evaluate the concept of purchasing a substantial fraction of the electric power requirements and converting gas now fired in gas turbines to by-product SNG. In each study, the comparison will be carried out as a screening effort, and will be done in a depth necessary to permit making the appropriate engineering decisions and the determination of comparative economics.

36641 (FE—2367-7) **Effects of solvent characteristics on Wyodak coal liquefaction. Quarterly technical progress report, August—October 1977.** Silver, H.F.; Hurtubise, R.J. (Wyoming Univ., Laramie (USA)). 15 Nov 1977. Contract EX-76-S-01-2367. 10p. Dep. NTIS, PC A02/MF A01.

Efforts have been directed primarily toward producing and analyzing duplicate samples of liquefied Wyodak coal using Wyodak coal-derived recycle solvent from Wilsonville, Alabama, and hydrogenated products from this solvent. Solvent characterization procedures developed in previous phases of the program have been used to follow the effects of changes in the solvent used.

36642 (FE—2893-9) **EDS coal liquefaction process development. Phase IV. Monthly technical progress report, February 1—February 28, 1978.** Epperly, W.R. (Exxon Research and Engineering Co., Florham Park, N.J. (USA)). Mar 1978. Contract EF-77-A-01-2893. 56p. NTIS (US Sales Only), PC A04/MF A01.

A Ni/Mo-10 hydrogentation catalyst study was conducted in the 50 pound-per-day Recycle Coal Liquefaction Unit (RCLU-1). Preliminary results indicate that the liquefaction yield structure is similar to that using Co/Mo-10 catalyst. No obvious effects of hydrogen treat rate on yields and conversion were detected in the 2 to 6% treat rate range. Hydrotreating studies on four coal naphthas (Illinois/Wyodak, raw/caustic washed) were completed. Data analysis in progress shows that reformer feed specifications can be met with one-stage hydrofining for all four feeds. Hydrotreating studies were begun on 400/1000°F and 400+ °F EDS liquids from Illinois No. 6 coal. Ash fusion studies with IKG coke made from EDS Illinois bottoms are being conducted in a Small Fluidized Unit (SFU). At low superficial velocities of air and steam mixtures, friable, sintered ash deposits were formed at gasification temperature. Work is continuing to broaden the SFU results and to relate them to operating experience in other experimental gasification units. The IKG was prepared for operations scheduled through June. Modifications were made to reduce ash losses and to change the feed melt system for better unit service. The validation of the EDS Process Alternatives Model (PAM) for Wyoming coal was completed. (LTN)

36643 (IS—4383) **Alloy evaluation for fossil fuel process plants (liquefaction). Quarterly report, October 1, 1977—December 31, 1977.** Woods, C.M.; Scott, T.E. (Ames Lab., Iowa (USA)). 15 Jan 1978. Contract W-7405-ENG-82. 31p. Dep. NTIS, PC A03/MF A01.

Base properties have been determined for A387-74A-Gr. 22-Cl. 2 steel at various temperatures in inert environments. Tests have been completed to monitor the actual stress level as a function of exposure time in tensile samples loaded in pre-compressed rings. Samples were exposed under various stress levels at 900°F to determine the amount of creep during the 168 hour exposures. Results of all exposure tests (including samples under load during exposure with and without creep, in inert gas) revealed that no degradation of ambient temperature mechanical properties occurred.

36644 **Coal liquefaction process with removal of agglomerated insolubles.** Gorin, E. (to Continental Oil Co.). US Patent 4,075,080. 21 Feb 1978. Filed date 18 Feb 1976. 6p.

Production of a low ash liquid or liquefiable fuel from coal is effected by solvent treatment and separation of the undissolved solids. The latter are removed by first agglomerating the non-settling finely divided solids, and then effecting separation of the agglomerates in a downwardly moving ebullated bed of agglomerates where the upflowing fluidizing liquid is a wash solvent which preferably is a mixture of precipitating solvent and coal liquefaction solvent.

36645 **Process for the production of hydrocarbons from coal.** Lang, R.J. (to Exxon Research and Engineering Co.). US Patent 4,075,079. 21 Feb 1978. Filed date 9 Jun 1976. 20p.

Coal is liquefied by treatment with a hydrogen-donor solvent and gaseous hydrogen, a heavy bottoms product boiling primarily in excess of about 1000°F is recovered, and this bottoms product is then pyrolyzed with fresh coal to produce surprisingly high yields of liquid product. The coke formed during the pyrolysis step may be gasified to generate hydrogen for use in the liquefaction operation and additional gas which can be employed as a fuel or upgraded for other uses.

36646 **Methods of fluidized production of coal in situ.** Terry, R.C. (to In Situ Technology, Inc.). US Patent 4,069,868. 24 Jan 1978. Filed date 14 Jul 1975. 12p.

A method of producing combustible gases, synthetic crude oils, coal chemicals and heat from coal in situ utilizes the combined teachings of in situ gasification, liquefaction and pyrolysis in separated coal blocks.

36647 **New process for removing ash from coal liquefied by hydrogenation.** Sze, M.C.; Snell, G.J. *Ind. Pet. Monde, Gaz - Chim.;* **44**: No. 471, 61, 63-65(May 1976).

C-E Lummus in its Clean Fuel From Coal (CFFC) program has developed and patented a process which involves distillation of the ash-containing, catalytically desulfurized coal-hydroliquefaction reactor effluent to remove components boiling below 600°F, mainly an antisolvent (usually a straight-run kerosine fraction from an oil refinery). The topped feedstock is mixed with another antisolvent at 300°-600°F under moderate pressure, and the mixture is passed to a gravity settler, from which an ash-free overflow stream and a high-ash underflow stream are continuously withdrawn. The overflow stream is distilled to recover the antisolvent, paste solvent from the original feedstock, and the coal-derived hydroliquefaction products. The underflow stream is vacuum-distilled to recover any of the same fractions present, and the very-high-ash residue is coked. Ash removal efficiency is 98%, i.e., to 0.1% by wt total solids. Laboratory and pilot-plant data are reported. Flow diagrams, tables, graphs, and 11 references.

PYROLYSIS AND CRACKING

REFER ALSO TO CITATION(S) 36663

36648 **Study of the pyrolysis of Rhine lignite and iron oxide mixtures by thermogravimetry—chromatography coupling in the gaseous phase.** Soudan-Moinet, C.; Huu, V.T. *Ann. Mines Belg.;* 73-83(Jan 1977).

In order to compare the reducing power of lignite and coal in the presence of iron oxides, a study was made of the pyrolysis of coal mixtures and two iron oxides (haematite and magnetite). Thermogravimetry was used to show both the decomposition of the coal and the reduction of the oxides and gas-phase chromatography to detect the gases formed. The experimental methods and results are described. The results lead to the conclusion that the reduction using lignite occurs at a lower temperature: the use of lignite in the prereduction of iron ores is therefore of great practical interest.

BY-PRODUCTS

REFER ALSO TO CITATION(S) 37742

36649 Turning anthracite into an activated carbon. Batchelor, J.S.; Wilson, J. *Water Waste Treat.;* **20**: No. 6, 44-46(Jun 1977).

Paper gives a brief indication of some of the uses of anthracite, and describes the Anthrasorb process, the grades of Anthrasorb activated carbons available, and some important applications of activated carbons.

36650 Obtaining carbon absorbents from caking coals. Kostomarova, M.A.; Surinova, S.I. *Khim. Tverd. Topl.;* No. 6, 3-8(Nov 1976).

A method for obtaining spherical carbon adsorbents from caking coal without the use of binders has been studied. Optimum conditions were found for the basic stages of the process, and the results of the research are given as regards pore structure, adsorptive properties and mechanical strength.

PROPERTIES

REFER ALSO TO CITATION(S) 36598, 36599, 36632, 36638, 36641

36651 (FE—2278-8) Phase equilibrium and volumetric properties of coal-derived fluids. Quarterly report, December 16, 1977—March 15, 1978. Robinson, R.L. Jr. (Oklahoma State Univ., Stillwater (USA). School of Chemical Engineering). 1978. Contract EX-76-C-01-2278. 14p. Dep. NTIS, PC A02/MF A01.

The thermodynamic properties of fluid mixtures are required for accurate design of equipment in which such fluids are stored, transported or separated. The basic goal of the present project is to obtain data for components and conditions where information is currently lacking. The mixtures studied will be chosen to approximate those which occur in the processing of coal-derived fluids. The research is divided into three major areas as follows: (1) design, construction and operation of a Burnett-type apparatus for measurement of volumetric properties (pressure-volume-temperature-composition relationship) of gases, and measurement of the properties of the pure substances and selected mixtures of H_2, CO, CO_2, CH_4 and H_2O at conditions from ambient to 800°F and 2,000 psia; (2) design, construction and operation of a variable-volume, windowed phase-equilibrium cell capable of operation to 800°F and 2000 psia, and measurement of vapor-liquid equilibrium in mixtures composed of selected light hydrocarbons/heavy aromatic hydrocarbons/water; and (3) testing and/or devlopment of prediction methods for estimation of volumetric properties and phase equilibrium in mixtures of the type studied experimentally, and presentation of results in formats suitable for use in process design calculations.

36652 (FE—2316-5) Study of the mineral matter distribution in pulverized fuel coals with respect to slag deposit formation in boiler furnaces: Phase I. Interim report, April—June 1977. Austin, L.G.; Essenhigh, R.H.; Gootzait, E.; Strickler, D.; Ohmine, S.; Morris, B.; Moza, A.K. (Pennsylvania State Univ., University Park (USA)). Oct 1977. Contract EX-76-S-01-2316. 31p. Dep. NTIS, PC A03/MF A01.

Particles of several minerals were examined under the SEM in order to compare the results obtained from the analyses of dispersed and polished samples. Keeping the SEM operating conditions constant, 5 or 6 particles were examined for each dispersed and polished sample. The results of the SEM analysis have shown that there is a much wider distribution of x-ray counts for dispersed particles as compared to polished samples. Based on this work, it has been concluded that it will be very desirable to have some method of correcting for geometric effects, for measurements on dispersed samples. The reconstruction of the plug flow furnace has been completed and a series of furnace characterization tests has been started. The new furnace has double the wall thickness of the original furnace in order to decrease the wall heat loss and thus to help promote slagging. Initial tests indicate that the furnace wall temperatures show only a slight increase in the peak temperature, however the peak temperature and the flame front have shifted in an upstream direction, leading to a higher average wall temperature. Work on the development of the cooled deposit collection probes is continuing. The first phase of the work on Wetting and Contact Angle measurement has been completed. The Abstract and the Conclusions from the student's dissertation are reported.

36653 Means for measuring the plasticity of coal. Brockschmidt, W.H.; Brockschmidt, R.W.; Grabenhofer, J.D. (to Fuel Research and Instrument Co.). US Patent 4,074,561. 21 Feb 1978. Filed date 15 Nov 1976. 4p.

A device for measuring the plastic characteristics of coal includes a bath of molten metal and a crucible with a coal sample therein positioned within said bath. A drive motor is connected through a hysteresis brake to a stir rod positioned in the coal sample. As the coal sample plasticizes due to heat from the molten metal, a calibrated disc connected to the stir rod will be driven by the motor. Optical sensing meeans including a photo-transistor and a light source positioned on opposite sides of the calibrated disc are connected to a counter which is used to record stir rod movement within a given time reference.

36654 Interaction between a coke and a tar. II. Limit of tar penetration in coke porosity. Lahaye, J.; Aubert, J.P.; Buscailhon, A. *Fuel;* **56**: No. 2, 188-191(Apr 1977).

The limit of penetration of a given coal-tar pitch into two cokes during mixing of the coke and liquid tar has been studied. It was shown that tar penetration is limited by compression of gas occluded in pores. Mercury porosimetry of cokes and pyrolysed coke tar mixturs as well as micrographs of cokes impregnated with tar allow one to estimate the limiting pore diameter of tar penetration into coke at ca. 6 micrometres for the system considered.

36655 Self-ignition and mechanisms of interaction of coal with oxygen at low temperatures. I. Changes in the composition of coal heated at constant rate to 250 C in air. Marknov, V.N. *Fuel;* **56**: No. 2, 153-157(Apr 1977).

The changes in weight, in elementary composition, in content of oxygen functional groups and in spin concentration of lignite, brown and black coal samples heated in a stream of humid air at a rate of 1 C/min to various temperatures have been determined. I.r. spectra of oxidized and non-oxidized brown coal are recorded and the yields of carbon monoxide, carbon dioxide and water were measured. The mixtures of low-molecular-weight hydrocarbons evolved before self-ignition were analyzed by gas chromatography, and the temperatures of self-ignition were determined in an oxygen stream using a Leitz microscope. A region of coal oxidation was identified where the hydrogen content remained invariable or increased, indicating an interaction of coal with water in the presence of oxygen. For the next region the atomic ratio H/C of the overall gaseous product was found to be high (6 to 10). Self-ignition was found to occur in this region. The results permit coal oxidation to be considered as a redox process. The aromatic part of coal is believed to act as an oxidizing agent in the region where hydrogen is less affected by molecular oxygen.

36656 Chemical reaction between hot ferric sulphate solution and iron disulphide in the Miocene coals of Taiwan. Youh, C.C. *Fuel;* **56**: No. 2, 226(Apr 1977).

The standard British and American methods determining sulfur in coal fail to allow for the possible presence of elementary or baritic sulfur in some coals. The author has studied the reaction of hot ferric sulfate solution with pyrite or marcasite in the Miocene coals of Taiwan, and has developed an analytical procedure for determining the amount of iron-sulfide decomposed and the amount of elementary sulfur deposited.

36657 Average analyses of SA coals. *Coal, Gold Base Miner. South. Afr.;* **25**: No. 4, 141-151(Apr 1977).

Average analyses of some South African coals are tabulated and are commented on briefly.

36658 Reflectance of fusains. McCartney, J.T. *Fuel;* **56**: No. 2, 223-224(Apr 1977).

Reflectance distributions in fusains from four US coals of different rank have been determined. The results of these measurements are tabulated, together with reflectance data on fusians in four British coals and analyses of vitrains and fusains in the coals considered. It was found that there is appreciable metamorphic change in the semifusinites with increase in rank.

36659 Multidimensional statistics for processing coal-petrographic data. Volkova, I.B.; Tarakanov, A.S. *Khim. Tverd. Topl.;* No. 6, 33-42(Nov 1976).

Chemical and coal-petrographic data were analyzed to elucidate the quantitative part played by processes responsible for the ultimate quality of the coal. Seams were examined and the conclusion is that multi-dimensional statistics provide evidence of relationships between the various properties of the coal and also lead to a number of new quantitative relationships between formations of varying age and rank.

36660 Chemical composition of hydrocarbon gases from a number of coal strata in the Donets Basin. Alekseev, F.A.; Voitov, G.I.; Lebedev, V.S.; Lebedev, V.S. (Inst. of Nuclear Geophysics and Geochemistry, Moscow). *Dokl. Akad. Nauk SSSR;* **230**: No. 3, 697-700(21 Sep 1976). (In Russian).

Pieces of coal were subjected to gas desorption in three stages at temperatures of 20, 60 and 100°C. The gases were analyzed chromatographically or by flame ionization. In early stages of coal formation (brown coal) it was found that CO_2 is mainly evolved. The role of methane becomes noticeable during soft coal formation, and plays an ever increasing part. Small amounts of the higher hydrocarbons were detected. 12 references. (SJR)

36661 Influence of the surface properties of Donbass coals on the adsorption of n-carboxylic acids from aqueous solutions.

Przhegorlinskaya, R.V.; Zubkova, Yu.N. *Solid Fuel Chem. (USSR) (Engl. Transl.);* **10**: No. 4, 126-129(1976).

Molecules of n-carboxylic acids are bound to the hydrophobic regions of the coal surface by the carbon radical. In regions having oxygen containing functional groups, the adsorbed molecules of water are held on the surface by a hydrogen bond.

36662 Study of the properties of aqueous suspensions of coal in the presence of surface-active agents. Rukin, E.I. *Solid Fuel Chem. (USSR) (Engl. Transl.);* **10**: No. 4, 134-139(1976).

The properties of coal and water suspensions in the presence of viscosity depressants was studied. The relationship between the structure of the reagents and the effectiveness of their liquefying and stabilizing action is outlined. The effectiveness of typical organic reagents increases in an alkaline medium, whereas the effectiveness of inorganic agents (sodium hexameta- phosphate, water glass) decreases.

36663 Primary heat engineering characteristics of the gas from thermal decomposition of coal. Akhmedov, R.D.; Akbarov, G.A.; Iskanderov, S.G. *Tr. Vnii Ekon., Organiz. Proiz-va i Tekhn.-Ekon. Inform. V. Faz. Prom-sti;* No. 1-2, 194-200(1974). (In Russian).

Characteristics of the gas produced by thermal decomposition of coal are presented, including the chemical composition, heat of combustion, air consumption for combustion of 1 m^3 of gas, volume and composition of combustion products and their heat capacity, maximum heat content of combustion products, maximum and calorimetric combustion temperature, ratio of dry and moist combustion products, ratio of volumes of water vapor and carbon dioxide in the combustion products. A I-t diagram is presented for the process of combustion of the gas for air flow factors (α) of 1-2, air preheating temperatures of 0 to 1200°C.

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 36707, 36865, 37250, 37252

36664 (CONF-7710112—, pp 150-164) **Mathematical model for determining the optimal locations of coal mine drainage neutralization plants.** Miknis, J.J.; Lovell, H.L. (Pennsylvania State Univ., University Park). 1977.

From 7. symposium on coal mine drainage research; Louisville, KY, USA (18 Oct 1977).

In Seventh symposium on coal mine drainage.

The paper has presented a prescriptive, non-linear mathematical model capable of assisting water quality planners in their efforts to control coal mine drainage pollution. The prescriptive model developed is an efficient tool that can be used for the preliminary screening of many coal mine drainage control strategies. This preliminary screening is often needed in large comprehensive river basin planning projects prior to a more detailed data collection and simulation analysis.

36665 (CONF-7710112—, pp 165-184) **Impact of gob and powerplant ash disposal on ground water quality and its control.** Libicki, J. (Central Research and Design Inst. for Opencast Mining, Wroclaw). 1977.

From 7. symposium on coal mine drainage research; Louisville, KY, USA (18 Oct 1977).

In Seventh symposium on coal mine drainage.

The planned fast development of coal mining and coal-fired power plants in the United States of America and in other countries will produce respectively greater amounts of refuse and fly ashes. At the same time, the wider use of surface mining methods will create numerous old abandoned open-pits which can be utilized for gob and ash disposals. However, this seemingly rational solution conceals a very serious danger in that there is a possibility of ground water pollution with substances leached from the disposed waste material. These substances filtrating to the aquifers may migrate long distances, polluting large volumes of water within aquifers, which are used for drinking and for commercial purposes. As a result, more stringent environmental requirements for groundwater protection can be expected. In 1973, the confluence of these two problems stimulated a joint project between POLTEGOR (Poland) and the U.S. Environmental Protection Agency with the following objectives: The determination of the influence of gob and fly ash disposal on groundwater quality; proposition to ameliorate the influence of the storage on groundwater and reclamation; and providing investigation and monitoring systems recommendations. To meet these program goals two test disposal sites were constructed and systematically observed. These investigations demonstrated the existence of an unquestionable influence by the gob storage on the deterioration of groundwater quality. The investigations clearly suggest the necessity of an effective division of the waste material coming from the coal mines and coal-fired power plants into subgroups. These subgroups should be based upon mechanical and chemical characteristics of leaching toxic compounds from the waste in a water environment. The disposal of each subroup can then be planned according to the degree of hazard involved. Various disposal plans are considered. (LTN)

36666 (CONF-7710112—, pp 185-193) **Water pollution from drainage and runoff of wastewater from coal storage areas.** Wachter, R.A. (Monsanto Research Corp., Dayton, OH). 1977.

From 7. symposium on coal mine drainage research; Louisville, KY, USA (18 Oct 1977).

In Seventh symposium on coal mine drainage.

Predicted water pollutants from the representative coals stockpile create runoff concentrations that enter the nearest waterway in levels from one to seven orders of magnitude less than water quality criteria. However pollution from these sources is a site-specific problem. Large, aged coal stockpiles located in areas of frequent rainfall will generate much higher effluent concentrations. In addition, the time of year is important. Coal pile runoff in the summer, when waterways have low flow rates and high temperatures, are more damaging than in the wintertime. Therefore, specific sites are better studied using the effluent factors per coal region (coal type). The runoff quantities for that site (and time of year) can then be estimated using local meteorological data and estimated runoff coefficients. Site-specific runoff concentrations can then be computed and compared with hazardous levels and effluent limitations. The need for control technology can then be established. While control of effluents from coal stockpiles is not widely practiced, the best practicable control technology currently available is collection, neutralization, and sedimentation. These treatments are best for pH and TSS control. Process design considerations include construction of drainage ditches, installation of surface covering with drainage to a sump, storage in bins and hoppers with runoff into trenches, and establishment of vegetative surroundings to retard runoff, erosion, and sedimentation.

36667 (CONF-7710112—, pp 223-231) **Treatment of precipitation runoff from coal storage piles.** Ferraro, F.A. (American Electric Power Service Corp., Canton, OH). 1977.

From 7. symposium on coal mine drainage research; Louisville, KY, USA (18 Oct 1977).

In Seventh symposium on coal mine drainage research.

The Belpre Coal Dock is a coal transfer facility in southeastern Ohio where local coal is brought in by truck and transferred onto barges on the Ohio River for shipment to AEP System plants. At times, up to 200,000 tons of coal covering approximately 7.5 acres have been stored at this facility. The majority of the coal stored here is of medium to high sulfur content (2 to 4% wt.). Typically, the rainfall runoff from the coal storage area has a pH of less than 3.0, a total iron concentration between 20 and 3,000 ppM and acidity of over 2,000 ppM. In 1973, it was decided that this runoff would require treatment prior to discharge to the Ohio River, and a consultant, International Hydronics Corporation, Princeton, New Jersey, was asked to assist in the design and engineering of a system that would treat the intermittent flows and highly variable quality water resulting from the rainfall and snowmelt runoff from the coal pile. Because the chemistry of the runoff water was similar to acid drainage from coal mines on which there has been extensive development of treatment technology, it was decided that the simplest, most effective treatment would be lime neutralization, aeration and settling of precipitated calcium sulfate and metallic oxides and hydroxides. Lime neutralization was chosen because it would be the most cost effective for this facility, however, sodium hydroxide or soda ash could also have been used. Two facilities built for the collection and neutralization of water runoff are described.

36668 (CONF-7710112—, pp 232-255) **Quality and treatment of coal pile runoff.** Cox, D.B.; Chu, T.Y.J.; Ruane, R.J. (Tennessee Valley Authority, Chattanooga). 1977.

From 7. symposium on coal mine drainage research; Louisville, KY, USA (18 Oct 1977).

In Seventh symposium on coal mine drainage research.

Coal pile drainage is a highly acidic waste stream containing high concentrations of a wide variety of inorganic constituents. Further, the acidity of this waste stream may not be governed by sulfur content of the coal. However, transfer of this drainage to an ash pond, where neutralization and precipitation occur, appears to provide adequate treatment.

36669 (TID—28185) **Status of flue gas desulfurization applications in the United States: a technological assessment.** (Federal Power Commission, Washington, D.C. (USA)). Jul 1977. 538p. Dep. NTIS, PC A23/MF A01.

The removal of sulfur compounds from the stack gases of coal-burning, electric power plants has been a national issue for the past decade. Desulfurization of flue gases by devices commonly referred to as "scrubbers" is a major approach to the problem but their use has been the subject of continuing controversy. Still unresolved are questions concerning their suitability for commercial

utility operations, the relative merits of one design over another, the feasibility and costs of sludge disposal for "throwaway" systems, the outlook for improved, second generation systems, and perhaps, most important, whether the complex chemistry and health effects of airborne sulfur oxides are sufficiently well understood to be sure that heavy investments in scrubbers will produce the desired results. Definitive answers to these questions do not yet exist, yet decisions must be made. This report is intended to be a basic reference and information source. The report does not attempt to provide ultimate conclusions, although there are a number of specific findings. It is primarily a descriptive assessment. Alternative technologies for meeting air pollution control regulations are discussed including: Use of low-sulfur, conforming coal; coal washing; supplementary control systems and tall stacks; solvent-refined coal; coal gasification and fluidized-bed combustion. The potential of flue gas desulfurization and these alternative technologies are discussed. Regulatory pressures relative to the installation of scrubbers are the result of the administrative and judicial implementations of the Clean Air Act. The financial costs of scrubber installations are compared with the most commonly applicable alternative: Burning western, low-sulfur coal.

36670 **Sulfur dioxide with coal.** Ratcliffe, C.T.; Pap, G. (to Allied Chemical Corp.). US Patent 4,071,606. 31 Jan 1978. Filed date 13 Dec 1976. 4p.

A process is described for producing sulfur by the reaction of sulfur dioxide with agglomerating coal. The purity of the product gases is improved and the tendency of the coal to agglomerate is reduced by employing coal particles having a particle size below 500 microns.

36671 **Spatial and time distribution of dust in the flue of large boilers.** Buehne, K.W.; Tockel, W. *Staub-Reinhalt. Luft;* **37**: No. 5, 189-194(May 1977).

When installing emission monitoring systems in power plants, in some cases it is not sufficient to know only the mean dust load value across the total area. To obtain more information on dust profiles, detailed measurements were made in the flue gases of seven coal-fired boilers. In the field tests, different emission monitoring systems were used simultaneously, and the results were compared with those of gravimetric determination of the dust load. Hints are given on suitable positions for monitoring systems.

36672 **Utilisation of power station ash.** Broderick, B.W. *Doc. - Combust. Eng. Assoc.;* No. 9675, vp(1976).

Paper describes the type of ash, the general commercial background and the current uses of ash.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 36664, 36666, 36706, 37512, 37514, 37952, 37953, 37954, 37985, 37986, 38261, 38271

36673 (CONF-7710109—) **Fifth symposium on surface mining and reclamation. NCA/BCR coal conference and Expo IV.** (National Coal Association, Washington, D.C. (USA); Bituminous Coal Research, Inc., Monroeville, Pa. (USA)). 1977. 325p. Dep. NTIS, PC A15/MF A01.

From 5. symposium on surface mining and reclamation; Louisville, KY, USA (18 Oct 1977).

The Fifth Symposium on Surface Mining and Reclamation, sponsored by the National Coal Association and Bituminous Coal Research, Inc., was held at the Kentucky Fair and Exposition Center, Louisville, Kentucky, October 18-20, 1977. Twenty-six papers from the proceedings have been entered individually into EDB and ERA. Topics covered include spoil bank revegetation, use of aerial photography, reclamation for row crop production, hydrology, computer programs related to this work, subirrigated alluvial valley floors, reclamation on steep slopes, mountain top removal, surface mine road design, successional processes involved in reclamation, land use planning, etc. (LTN)

36674 (CONF-7710109—, pp 1-3) **Classification of five types of strip mine spoil and implications for reclamation.** Hall, G.F. (Ohio State Univ., Columbus). 1977.

From 5. symposium on surface mining and reclamation; Louisville, KY, USA (18 Oct 1977).

In Fifth symposium on surface mining and reclamation.

With increasingly stringent state and federal laws concerning the reclamation of strip mine spoil material, there is increased need for an understanding of the properties of the spoil material. One method by which to improve this understanding is through soil survey classification and mapping of the spoil material following those principles set forth in the new USDA Soil Taxonomy. A fundamental goal in the classification and mapping of any soil is to allow the information gained in one area on a given soil to be transferred to another area where that same or similar soil occurs. This information may relate to use and management in either agricultural or non agricultural areas. The steps followed in a soil survey classification and mapping program are: determination of soil characteristics, establishment of classes in a system of classification, determination of boundaries between the soils as they occur in the field and a plot of the boundaries on a map, and prediction of behavior of the different soils under different treatments and uses. The ultimate goal of the soil survey classification and mapping program is to make accurate predictions for any user of the soil. The basic unit of concern in this paper is the soil series which is the lowest category in the USDA Soil Taxonomy system. Differentiation of soil series is based on soil thickness, mineralogy, structure, consistence, texture, moisture and temperature regimes as well as many other properties related to genesis and use.

36675 (CONF-7710109—, pp 4-7) **Utilization of color and color infrared aerial photography in the surface coal mining process.** Knuth, W.M.; Fritz, E.L. (HRB-Singer, Inc., State College, PA). 1977.

From 5. symposium on surface mining and reclamation; Louisville, KY, USA (18 Oct 1977).

In Fifth symposium on surface mining and reclamation.

Remote sensing systems are scientific instruments for quantitative measurements and qualitative observation directed at securing and utilizing information. However, they must not be construed as ends in themselves. Remote sensing should rather be considered as a means to an end. Considerable basic research in remote sensing has been underway for several years. It is hoped that this discussion will serve to bridge the gap between basic research and operational needs. The authors firmly believe that remote sensing related to planning and monitoring of surface coal mining activities has a definite future in the coal community provided (1) limitations of the sensors are clearly understood, (2) the level and reliability of the information content provided by the remote sensing data has been clearly established, (3) the real information requirements of the users are clearly established and (4) the economic benefit of such sensors can be shown. It is in this context that discussions of the use of color and color aerial photography in the surface coal mining process are included.

36676 (CONF-7710109—, pp 8-11) **Surface mine revegetation: area metering of ground cover.** Carrel, J.E.; DeMott, J.E.; Zwight, D.M. (Univ. of Missouri, Columbia). 1977.

From 5. symposium on surface mining and reclamation; Louisville, KY, USA (18 Oct 1977).

In Fifth symposium on surface mining and reclamation.

Vegetative ground cover, an important indicator of surface mine reclamation, can be remotely determined by a simple, two step technique. First, a transfer of plant cover visible in a large scale (1 : 2,500), vertical aerial photograph of the mineland is prepared by inking a clear plastic sheet. Secondly, the area occupied by vegetation is measured by passing the transfer through a leaf area meter. The method is rapid, accurate over the entire range of cover values, and inexpensive.

36677 (CONF-7710109—, pp 12-15) **Establishment of some forage species on mine spoil in Kentucky.** Everett, H.W.; Henry, D.S.; Sanders, S.A. 1977.

From 5. symposium on surface mining and reclamation; Louisville, KY, USA (18 Oct 1977).

In Fifth symposium on surface mining and reclamation.

In April 1976, a study was initiated to evaluate methods of establishing several potentially useful forage species on mine spoil in Kentucky. Eight different grasses and legumes were planted alone or in mixtures with five different methods of establishment. There were three replications of each method at two locations. pH was 6.0 or greater and a complete fertilizer was applied to all plots prior to seeding. Much of this study was made possible through a reimbursable agreement between the Environmental Protection Agency and the Soil Conservation Service. Analysis of variance (ANOVA) shows that there are no significant differences in 60-day stand counts at either location due to method of establishment. ANOVA shows there are significant differences in 120-day stand counts due to method of establishment for the site in eastern Kentucky (Location 1), but no differences at the western Kentucky site (Location 2). ANOVA shows there are significant differences in 60- and 120-day stand counts due to species seeded, at both locations. Percent ground cover and percent above ground biomass due to seeded species were evaluated in October 1976. ANOVA of these data shows there are significant differences in cover, biomass, and establishment methods for both locations.

36678 (CONF-7710109—, pp 16-19) **Revegetation of strip-mine spoils with containerized tree seedlings.** Goodman, S.D.; Koppe, T.F.; Hutnik, R.J. (Pennsylvania State Univ., University Park). 1977.

From 5. symposium on surface mining and reclamation; Louisville, KY, USA (18 Oct 1977).

In Fifth symposium on surface mining and reclamation.

Based upon these first-growing season results, it appears that two-year-old commercial stock planted in a bare-root condition is superior to one-year-old containerized conifer seedlings on a variety of surface-mined sites. Evidently, the extra year's growth more than compensated for the superior growing conditions within the greenhouse in producing healthy, sturdy seedlings. The severe weather conditions to which these seedlings were exposed is an especially complicating factor in regards to species evaluation. It may well be that species such as loblolly pine would have been excellent performers in the southern localities if the weather had been less extreme. Therefore decisions on which species to plant should not be based on the results of a single study but rather on consensus results of a number of studies. Again, it is too early to draw definite conclusions concerning the steps which must be taken to establish a good herbaceous cover on toxic sites. It does appear that, as a minimum, site preparation, liming, fertilizing and possibly mulching are essential steps. Whether or not topsoiling is also needed depends upon whether the cover becomes denser or thinner during the next few years. Although fescue so far has performed better than deertongue grass, the picture could change in years to come. Also birdsfoot trefoil may become a more important component of the herbaceous cover.

36679 (CONF-7710109—, pp 20-23) **Wildlife option in Kentucky.** Rosso, W.A. (Peabody Coal Co., Central City, KY); Wolcott, B.H. Jr. 1977.

From 5. symposium on surface mining and reclamation; Louisville, KY, USA (18 Oct 1977).

In Fifth symposium on surface mining and reclamation.

The reclamation of surface-mined land in western Kentucky provides the opportunity to establish some 2000 to 4000 acres of wildlife habitat each year. These reclaimed acres would create tremendous recreational potential over the years, at no direct cost to the Commonwealth of Kentucky. This opportunity is largely neglected at present. Up until recently Kentucky has offered two options in reclaiming spoils. The first option is a forest—plus 70% ground cover of grasses and legumes. The second alternative is a grass and legume pasture which requires 80% ground cover with approved grasses and legumes. Several interested parties throughout the state felt that a need existed to create a third option. This third option, the wildlife option, would logically be used in areas not suited or desired for the original two options. In the past, areas developed for wildlife could not reach their full potential without violating state reclamation regulations. The wildlife option is essentially a combination of the current two options. The main deviation from the original two options is the acceptance that as much as 15% of the area will be devoted to food plots and cover lanes.

36680 (CONF-7710109—, pp 25-27) **Research toward reclamation of surface-mined land for row-crop production.** Jansen, I.J. (Univ. of Illinois, Urbana). 1977.

From 5. symposium on surface mining and reclamation; Louisville, KY, USA (18 Oct 1977).

In Fifth symposium on surface mining and reclamation.

This study is directed toward questions concerning surface mining and subsequent reclamation of productive row-crop lands in the state of Illinois. The five year project has been underway for less than one year. Much of the study is being conducted on fresh surface-mine materials near active operations. Some older mined lands are also included to evaluate changes in mined-land soils that take place over time after reclamation. The general objective is to accumulate information that will provide for improved reclamation of Illinois surface-mined lands and prevent unnecessary or counter productive reclamation operations. The first step is to determine the characteristics of the land surface and the soils of surface mined lands both before mining and after reclamation. The procedure includes field investigation, laboratory analyses, interpretation of aerial photographs, and using available soils and geologic maps. The physical and chemical properties of the post mine soils will be related to premine soils, premine geologic column, coal strata mined, mining procedure, reclamation procedure, and time since reclamation. A system will be developed for mapping variability of soil material on mined land so that research results can be applied effectively. Several approaches are being used to identify factors that limit crop stand establishment, crop performance, and farming operations. Root volume studies will compare root system development in reclaimed soils to that in nearby undisturbed land. Features in the reclaimed soils that are favorable or unfavorable for root system development will be noted. Soil erosion hazard and crop stand problems on farmed spoil lands will be investigated to determine the severity and the cause. The hydrology of reclaimed lands, including infiltration, drainage, and water retention properties is being studied.

36681 (CONF-7710109—, pp 28-31) **Simulation model of spoil bank hydrology.** Crosby, E.C.; Overton, D.E.; Minear, R.A. (Univ. of Tennessee, Knoxville). 1977.

From 5. symposium on surface mining and reclamation; Louisville, KY, USA (18 Oct 1977).

In Fifth symposium on surface mining and reclamation.

The conclusions derived from this study are based upon optimized model verifications and simulations. They are, therefore, subject to the limitations imposed by the underlying assumptions and the fact that the data are site specific. Simulations of groundwater flow through the ponded spoil bank studied produced the following conclusions: Recharge to the saturated zone is primarily attributable to the pond. Travel time through the saturated zone from the pond to the toe of the spoil bank is approximately two years. Travel time of infiltrated water (percolation) through the unsaturated zone to the saturated zone is approximately six years at field capacity and assuming vertical percolation. Total seepage out of the spoil bank for one year is approximately 15 surface inches while the yearly rainfall is about 60 inches per year. It appears unlikely that a water table will form in this type of spoil bank from percolated water without the presence of a recharge for the following reasons: The steepness and bareness of the spoil bank produces a very high runoff potential, thus producing a low water infiltration potential; evapotranspiration is about 21 inches per year, further reducing the supply of percolated water; and percolation time appears to be extremely long. Hence, pollutant (dissolved metal) movement associated with water transport in or on the spoil bank is primarily attributed to surface runoff or high concentrations in small seepages where ponding occurs.

36682 (CONF-7710109—, pp 32-36) **ECOSITE: an application of computer graphics to the design of landforms for surface-mine reclamation.** Mallary, R. (Univ. of Massachusetts, Amherst). 1977.

From 5. symposium on surface mining and reclamation; Louisville, KY, USA (18 Oct 1977).

In Fifth symposium on surface mining and reclamation.

Although the importance of aesthetic quality is acknowledged by almost all concerned with reclamation and its improvement, this key factor is seldom preplanned like the environmental and other requirements of reclamation, nor are professional designers (landscape architects, for instance) usually involved in the preplanning process. To encourage the full assimilation of aesthetics into the preplanning process and to "get a handle on" an aspect of reclamation policy that continues to be far too elusive and subjective, a multidisciplinary Surface Mine Research Group at the University of Massachusetts is developing a "preplanning-and-design resource package." Essentially a how-to decision model, this package reflects a rigorously noncosmetic, systems-oriented approach in which the aesthetic factor, though stressed as an important value and objective in itself, is thoroughly coordinated with environmental specifications, the after-use of the site, regional and long-term planning considerations, and other important factors. A key component in this package is ECOSITE, an interactive program for computer-aided landform design that is the principal subject of this summary. This paper summarizes the essentials of ECOSITE in terms of its structure, operation, current capabilities, imminent improvements, and down-the-road performance objectives.

36683 (CONF-7710109—, pp 37-40) **Research on the hydrology and water quality of watersheds subjected to surface mining.** Hamon, W.R.; Haghiri, F.; Knochenmus, D. (North Appalachian Experimental Watershed, Coshocton, OH). 1977.

From 5. symposium on surface mining and reclamation; Louisville, KY, USA (18 Oct 1977).

In Fifth symposium on surface mining and reclamation.

Research plans to accumulate information on hydrology and water quality in four watersheds in Ohio which will be surface mined and in a control watershed are summarized. The various data to be collected are summarized. (LTN)

36684 (CONF-7710109—, pp 41-53) **Keeping things clean with SOAP and water.** Wiram, V.P. (AMAX Coal Co., Indianapolis). 1977.

From 5. symposium on surface mining and reclamation; Louisville, KY, USA (18 Oct 1977).

In Fifth symposium on surface mining and reclamation.

Over the past three and one-half years, AMAX Coal Company has been preparing to meet more stringent environmental regulations on both individual state and federal levels. As a responsible coal producer, AMAX has taken a long, hard look at our mining activities from two basic points of view, that of increasing coal production and achieving the goal with sound environmental input. First, we've solidified our desire to continue surface-mining and to improve our total effectiveness at getting more tonnage to the market. Secondly, we've committed operations to achieving our production goals through the design and use of environmentally sound mining and reclamation plans. Both goals are technically compatible and will prove to be the key to continued success in surface mining. Detailed pre-mine studies involving consideration of all major environmental factors provide the necessary ingredients for the preparation of the mining and reclamation plans. Operational follow through of such detailed planning is the critical path taken to achieve the dual goals of the Company. Two resources worthy of major consideration in the design of any surface mining and reclama-

tion plan are soil and water. This is exemplified in the recently enacted Surface Mining Control and Reclamation Act of 1977 where these resources are major environmental concerns. Productivity of mined lands must be equal to or better than that which existed prior to mining. The operator will be required to minimize disturbances to the prevailing hydrologic balance both on and off the mine-site. This paper outlines the objectives and methodologies of both the SOAP (Soil Overburden Analysis Program) and Hydrology programs. These programs are the vehicle to be used in bringing all surface-mine operations into total compliance with the Act.

36685 (CONF-7710109—, pp 54-60) **Illinois' mined land inventories: their implementation and utilization.** Nawrot, J.R.; Klimstra, W.D. (Southern Illinois Univ., Carbondale). 1977.

From 5. symposium on surface mining and reclamation; Louisville, KY, USA (18 Oct 1977).

In Fifth symposium on surface mining and reclamation.

Anticipating such a major State effort to deal with the environmental pollution associated with coal surface mining, Illinois Department of Mines and Minerals funded the Cooperative Wildlife Research Laboratory of Southern Illinois University at Carbondale in 1970 to conduct an extensive statewide survey of the status and quality of Illinois surface-mined lands. Recognizing that a complete inventory and assessment of unreclaimed mined lands and associated environmental problems were integral steps in carrying out the directives of the Illinois Abandoned Mined Lands Reclamation Act, the Illinois Institute for Environmental Quality funded the Laboratory in 1975 to conduct a similar survey of underground coal mining in Illinois. General objectives of the surface mine and underground mine surveys were: (1) to locate, determine size, and establish status of affected acreages; (2) to describe in detail the affected acreage including such aspects as the physical, vegetational, and chemical characteristics of spoilbanks, gob, slurry, tipple, and water areas; (3) to identify current utilization, reclamation effort, and/or natural rehabilitation; (4) to define the location and extent of problem areas; and (5) to establish biographic information for mine sites including dates of operation, mining company, method of mining, applicable reclamation law, seam(s) mined, and current ownership.

36686 (CONF-7710109—, pp 61-135) **Subirrigated alluvial valley floors.** Hardaway, J.E.; Kimball, D.B.; Lindsay, S.F.; Schmidt, J.; Erickson, L. (Environmental Protection Agency, Denver). 1977.

From 5. symposium on surface mining and reclamation; Louisville, KY, USA (18 Oct 1977).

In Fifth symposium on surface mining and reclamation.

Concern has been expressed regarding the long-term impacts of surface coal mining on lands in the western United States currently or potentially useful for agriculture. Part of this concern bears on disruption of these lands used by wildlife. In particular, there are questions regarding the potential impact of coal extraction in certain lowland areas of the semi-arid West where shallow ground water and/or soil moisture is adequate to support growth of grasses and forbs through the dry months. These land areas, located along drainage channels and referred to recently as "alluvial valley floors" (National Academy of Sciences, 1974), are most important in semi-arid and arid climates because water is "stored" in the alluvium, enabling vegetation to continue growth during the months of low rainfall. Apparently, soil moisture, and perhaps some near-surface ground water, subirrigates the vegetation. The alluvial valley floor areas include the principal surface water accumulation points, as well as points of ground water recharge and discharge. The composition of vegetation in subirrigated alluvial valley floors is important since some grass and legume species are more desirable as hay. Alluvial valley floors which have sufficient subirrigation to support agricultural use (harvesting of hay, for example) are, conceptually, important to the economy of the western United States. They must be protected. In view of the uncertainties caused by the few mining plans submitted to mine alluvial valley floors, it may be appropriate to temporarily defer surface mining of coal in subirrigated alluvial valley floors until a well-defined and comprehensive research program has provided additional information concerning the effects of mining under complex hydrologic conditions.

36687 (CONF-7710109—, pp 225-234) **Reclamation of toxic spoil disposal with Polish surface coal mines as an example.** Bauman, K. (Central Research and Design Inst. for Opencast Mining, Wroclaw). 1977.

From 5. symposium on surface mining and reclamation; Louisville, KY, USA (18 Oct 1977).

In Fifth symposium on surface mining and reclamation.

Terrains transformed during the course of the mining operation require reclamation and recultivation as a result of both economic and ecological considerations. As a result of widespread concern regarding the preservation and protection of the natural environment, more and more attention and effort are directed toward the effective reclamation of these lands. This demonstration project was developed to conduct and demonstrate the reclamation of a particularly difficult portion of the Turow open pit lignite mine in Poland. The Turow mine is located in southwestern Poland and produces in excess of 20 million tons of lignite per year. The working depth of the pit is approximately 200 meters and will eventually attain a depth of 250 meters. The spoil material is removed via wheel excavators and transferred to beltways which carry the spoil to storage areas some distance from the open pit. Over 70 million cubic meters per year of overburden are transported to the external stack. At the conclusion of the Turow operation (2020) the external stack will cover an area of about 6,600 acres to an elevation of 1000 feet above adjacent ground levels. A methodology has been developed for the biological and chemical transformation of the toxic stack material in order that vegetative cover can be established. This cover was established both on the flat top areas of the stack as well as on the steep outslopes. These areas are then subjected to variable conditions which included numerous neutralization and fertilization combinations and the planting of many species of vegetative cover. Soil science research and biometric measurements were conducted within the test plot areas. The main source of toxicity in the overburden resulting from the open pit operations are the iron sulfides.

36688 (CONF-7710109—, pp 235-244) **Reestablishment of wooded waterways and associated upland shrub communities in surface coal mining areas of the northwestern Great Plains.** Orr, H.K. (Rocky Mountain Forest and Range Experiment Station, Rapid City, SD). 1977.

From 5. symposium on surface mining and reclamation; Louisville, KY, USA (18 Oct 1977).

In Fifth symposium on surface mining and reclamation.

Based on revegetation tests of trees and shrubs in the Northern Great Plains area the following general conclusions can be drawn: The initial establishment of the species so far tested differ significantly; all but one of the species respond to supplemental water but degree of response differs significantly; supplemental water tends to reduce winter losses more than summer losses; overall response is higher for the conifer than for the deciduous species; container grown stock is superior for the conifer species; for deciduous species the initial survivals were higher for bare root than for container grown stock, except for one species for which there was no difference; no given species is consistently successful in terms of initial establishment; and survivals of individual species, especially the conifers, ranged from zero to very high for plantings in different years. For planting in waterways, variable combinations of cultural techniques and species can be used, depending on slope, aspect, and characteristics of the spoil. Low shrubs, such as big sagebrush, rabbitbrush, fourwing saltbush, and winterfat are establishable on south facing slopes and adjacent uplands, and the probability of success can be enhanced by contour furrowing to conserve moisture and minimize erosion. On lower to upper north facing slopes, taller species such as green ash, cottonwood, Russian olive, Siberian peashrub, and buffaloberry appear adaptable. Here, also, and in selected locations on other aspects, Rocky Mountain juniper, and some ponderosa pine can be expected to survive and establish, especially if given supplemental water together with application of measures such as contour furrowing and/or mulching designed to conserve moisture.

36689 (CONF-7710109—, pp 245-254) **Effects of fertilizer and acid strip mine spoil on germination of grass seeds.** Maddox, J.B.; Brown, J.E.; Bartley, G.N. Jr. (Tennessee Valley Authority, Norris). 1977.

From 5. symposium on surface mining and reclamation; Louisville, KY, USA (18 Oct 1977).

In Fifth symposium on surface mining and reclamation.

Seeds of all species sown on river bottom soil had a significantly higher germination percentage than those sown on the mine spoil control. The river bottom soil produced healthier seedlings with long and tapered white roots as opposed to short, blunt, and blackened roots of those which had germinated on the mine spoil. Triple superphosphate (TSP) significantly increased germination of orchard grass and redtop over the mine spoil control while ammonium nitrate (AN) suppressed germination of all species except redtop. Germination percentage of TSP-treated seeds was significantly higher than that for AN-treated seeds. Since the pH of AN slurries was higher than that for TSP slurries, the decrease in germination percentage was probably caused by salt concentrations produced by nitrogen fertilizer rather than slurry acidity. Some species are more tolerant to certain slurry concentrations than others. However, it is evident that the fertilizer rate (168 Kg AN/ha + 280 Kg TSP/ha) recommended by some revegetation guidelines is detrimental to the germination of annual and perennial ryegrass when hydraulically seeding acid spoils. Seeds treated with TSP alone and sown on the mine spoil resulted in seedlings with healthier looking shoots and longer roots than those receiving the other fertilizer treatments. This was most pronounced at the high concentrations of TSP. When hydraulically seeding grasses on acid spoil, ammonium nitrate, at the rate of 112 Kg/ha or greater, should always be applied with some

other amendment such as triple superphosphate. Perhaps ammonium nitrate can be applied alone at lower rates without suppressing seed germination. Annual and perennial ryegrass are more sensitive to the spoil and fertilizer treatments than other species and caution should be taken when applying these seeds in a slurry mixture of ammonium nitrate and triple superphosphate. Triple superphosphate can be used alone at rates up to at least 336 Kg/ha with no detrimental effect.

36690 (CONF-7710109—, pp 255-273) **State of the Art of reclaiming land surface-mined for coal in the western Kentucky coal field.** Powell, J.L. (Peabody Coal Co., Central City, KY); Barnhisel, R.I.; Akin, G.W.; Ebelhar, M.W. 1977.

From 5. symposium on surface mining and reclamation; Louisville, KY, USA (18 Oct 1977).

In Fifth symposium on surface mining and reclamation.

A summary of five years of research and observations are presented that hopefully can be used as guidelines in planning, implementing and maintaining of a sound reclamation program. Some post-mining land use alternatives are discussed.

36691 (CONF-7710109—, pp 274-282) **Advantages of natural successional processes on western reclaimed lands.** Moore, R.T.; Ellis, S.L.; Duba, D.R. (Ecology Consultants, Inc., Fort Collins, CO). 1977.

From 5. symposium on surface mining and reclamation; Louisville, KY, USA (18 Oct 1977).

In Fifth symposium on surface mining and reclamation.

Recently enacted reclamation guidelines and regulations for several western states have emphasized the use of native species in revegetation of surface mined lands. These regulations are typically adopted in an effort to insure full restoration of premining values for livestock grazing or other existing uses. The arguments are commonly advanced that (1) only native species have the potential for long-term survival on a given site in the face of a fluctuating environment, and (2) a diverse mixture of species is necessary to provide ecosystem stability during such environmental fluctuations. It is the authors' contention that while this approach may involve noble intentions, it ignores many important ecological principles and is based on others which are either poorly understood or commonly miscontrued. Instead of attempting to immediately restore a near climax plant community on mined land in a single step, it seems preferable to plan the revegetation and reclamation program around the ecological processes occurring on the site. Thus, annual species which invade reclaimed areas or are present in topsoil used for reclamation, and certain introduced species should be considered an integral part of early successional development of the revegetation community.

36692 (CONF-7710109—, pp 283-297) **Land restoration: the Iowa experiment.** Sendlein, L.V.A. (Southern Illinois Univ., Carbondale); Anderson, C.E.; Gulliford, J.B. 1977.

From 5. symposium on surface mining and reclamation; Louisville, KY, USA (18 Oct 1977).

In Fifth symposium on surface mining and reclamation.

A demonstration surface mine, coal preparation plant and land reclamation project are underway by the Iowa State University. Emphasis is given to the economics involved and to environmental effects and their minimization. (LTN)

36693 (CONF-7710109—, pp 298-305) **Management of reclaimed surface-mined lands for row crop production.** Henning, S.J. (Iowa State Univ., Ames); Colvin, T.S. 1977.

From 5. symposium on surface mining and reclamation; Louisville, KY, USA (18 Oct 1977).

In Fifth symposium on surface mining and reclamation.

Surface mining coal and other minerals in Iowa will generally take place where the land can be used for agricultural production. However, intensive agricultural production of row crops such as corn and soybeans at reclaimed surface mines places many demands on the land. Pre-planning for row crops is essential but the benefits of planned restoration may not be realized without proper post-restoration management. The pre-planning criteria used to develop a restoration plan suitable for row crop farming is given for the Iowa Coal Project Demonstration Mine. Corn and soybeans were grown on a restored portion of the Demonstration Mine with moderate success in the first year after restoration. Desired plant densities will require good seedbed preparation and that may require heavier than normal farm tillage implements. Likewise, seed planters should also be heavier than normal. It appears that machinery suitable for minimum tillage or zero-tillage row cropping may be used to advantage on restored soils at surface mining operations or other disturbed sites. In addition to preparing an adequate seed bed at the land surface, consideration should be given to subsoil tillage to provide a suitable medium for plant root growth and development. In this study, an agricultural subsoiler proved superior to a bulldozer ripper because the latter increased the difficulty of preparing a good seed bed.

36694 (CONF-7710109—, pp 306-310) **Effects of grazing intensity on vegetation and animal performance on reclaimed strip-mined land.** Hofman, L.; Ries, R.E.; Power, J.F.; Lorenz, R.J. (Northern Great Plains Research Center, Mandan, ND). 1977.

From 5. symposium on surface mining and reclamation; Louisville, KY, USA (18 Oct 1977).

In Fifth symposium on surface mining and reclamation.

Reclaimed strip-mined land in North Dakota is somewhat fragile and the effects of grazing these lands are unknown. To study these effects, we stocked duplicate sets of pastures at 0, 0.24, 0.48, and 0.72 ha/yearling steer to obtain control, heavy, moderate, and light grazing intensities, respectively, on land reclaimed under the state's 1969 reclamation law near Center, North Dakota. A mixture of cool-season grasses and legumes was seeded in 1973 and not harvested before beginning the study in 1976. During 1976, 3734 kg/ha dry matter was produced on the ungrazed control, and 80, 44, and 32% of the forage was grazed at the heavy, moderate, and light grazing intensities, respectively. The 1976 grazing season was 55 days as compared with 30 days in 1977, which had a much drier spring. In 1977, the heavily grazed pasture had significantly less dry matter than the other treatments when grazing was started. When grazing was stopped, no harvestable forage remained on the heavily grazed pastures. Steers on heavily grazed pastures produced average daily gains of 0.4 kg/head as compared with 0.9 kg/head on the moderately and lightly grazed pastures. Beef production in 1977 equalled 55, 58, and 41 kg/ha for the heavy, moderate, and lightly grazed pastures, respectively. These preliminary data indicated that reclaimed mined land should be suitable for grazing, but additional research is needed to establish good grazing management guidelines for reclaimed land.

36695 (CONF-7710109—, pp 311-317) **Land use planning in surface mine areas.** LaFevers, J.R. (Argonne National Lab., IL); Imhoff, E.A. 1977.

From 5. symposium on surface mining and reclamation; Louisville, KY, USA (18 Oct 1977).

In Fifth symposium on surface mining and reclamation.

Pre-mine reclamation planning has long been recognized as an essential element in any cost-effective extraction/reclamation program. There is an additional need, however, to carry the planning process a step further to include local and regional land use planning elements in the reclamation planning process. In that way, mined areas could be reclaimed to help satisfy specific local land use needs and comply with land capabilities, rather than merely revegetated to satisfy legal requirements. Such a planning program could be beneficial to both the mining company and the public. The public would benefit by having land use suitability, whereas the company would benefit from making their reclaimed land more marketable. This type of integrated reclamation/land use planning program will generally require input from both industry personnel and public sector planners. A land use needs inventory for the community, and other data necessary for the development of marketing strategies should be provided to the mining company by public planning agencies in whose jurisdiction the mine will be operating. In reciprocation, the mining company could provide to planning agencies information valuable in the generation of future development scenarios. Water and other mineral availability data, analyses of the overburden and the likely effect of disturbance and baseline data relating to archeological, social, historical, biological and other resources could be provided to planning agencies by the mining company and used for their mutual benefit.

36696 (CONF-7710112—, pp 194-222) **Measurement and modeling of storm water runoff from coal storage piles and the impact on receiving waters.** Brookman, G.T.; Binder, J.J.; Wade, W.A. III. (TRC-The Research Corporation of New England, Wethersfield, CT). 1977.

From 7. symposium on coal mine drainage research; Louisville, KY, USA (18 Oct 1977).

In Seventh symposium on coal mine drainage.

In January, 1976, TRC--The Research Corporation of New England was retained by the Industrial Environmental Research Laboratory of the U.S. Environmental Protection Agency to evaluate waterborne fugitive emissions (non-point sources) in relationship to industrial activities. This paper presents the highlights of the coal-fired utility storm water measurement program. The major emphasis of this paper is on runoff from coal storage piles. Included is a description of the mathematical model used for predicting runoff from coal-fired utilities and its application to the sites measured. The pollutant concentrations in the river at both sites were highly variable, often by an order of magnitude. These variations were independent of river flow and weather conditions. The data from these two sites generally show no statistical difference in mean concentrations of upstream versus downstream pollutant levels in either dry or wet conditions.

36697 (DOE/EDP—0010) **Environmental Development Plan (EDP): direct combustion program, FY 1977.** (Department of Energy,

Washington, D.C. (USA)). Mar 1978. 153p. Dep. NTIS, PC A08/MF A01.

This document addresses possible environmental, health and safety impacts associated with the following new technologies in the ERDA Fossil Energy program for the direct combustion of coal: Atmospheric Fluidized Bed Combustion (AFBC), Pressurized Fluidized Bed Combustion (PFBC), and Coal/Oil Mixtures (COM). A considerable effort is also dedicated to the environmental issues associated with conventional coal combustion technology. This EDP is mainly focused on the new technologies, but identifies research activities related to the environmental effects of conventional coal combustion since many of the problems and controls are similar. These EDP's are being distributed now so that all having interests and responsibilities may assist in a planned revision and update.

36698 **New life from scorched earth.** *Contract J.;* **276**: No. 5090, 26-27(Mar 1977).

Sunderland borough council are reclaiming the former Silkstone Colliery site for use as a leisure area. The major problem was removing a burning tip heap before the area could be landscaped.

RESERVES AND EXPLORATION

REFER ALSO TO CITATION(S) 36613

36699 (BM-IC—8760) **Anthracite in the Narragansett Basin of Rhode Island and Massachusetts.** Barton, W.R.; Skehan, J.W.; Deurbrouck, A.W.; Murray, D.P. (Bureau of Mines, Newmarket, N.H. (USA); Boston Coll., Weston, Mass. (USA). Weston Observatory; Bureau of Mines, Pittsburgh, Pa. (USA). Coal Preparation and Analysis Lab.). 1977. 18p. of Mines, Washington, DC.

Anthracite has been mined from the Narragansett Basin of Rhode Island and Massachusetts sporadically, and with limited success, for more than 170 years. Beginning in 1974, interest in the coal of the Basin was renewed because of increasing prices and supply uncertainties involving petroleum products. During 1974—77 the Bureau of Mines analyzed 28 samples of Basin coals and conducted washing tests on 20 of them. Results, reported herein, indicate that the coals are low-sulfur, moderate- to high-ash anthracites and semianthracites, suitable for physical preparation to a product generally containing less than 10 percent ash. Additional exploration, sampling and testing will be required to permit appraisal of the potential value of the Narragansett Basin coal resources.

36700 **GEOLOG: a computer-based scheme for detailed analysis of stratigraphy, especially as applied to data from drill holes in coal exploration or development.** Godwin, C.I. (Univ. of British Columbia, Vancouver); Hindson, R.E.; Blanchet, P.H. *CIM Bull.;* **70**: No. 783, 123-132(Jul 1977).

Geolog is a computer-oriented technique for recording and interpreting geological field observations (particularly with respect to drill core and cuttings) for various kinds of mineral deposits. The modification of the general system for application to coal and other sedimentary deposits is presented. This stratigraphic version has been tested by a successful application to the description and interpretation of data from 15 drill holes totalling 14,600 feet (4,450 meters) on a coal-bearing property in the Peace River area of British Columbia. Drill-hole data are collected on an 80-column, fixed-format listing that includes (a) interval described, (b) core recovery, (c) rock type (lithologies can be described in great detail), (d) structural features, (e) regional lithologic units and (f) accessory minerals, etc. Terminology in Geolog is keyed to logical word abbreviations and simple codes, resulting in concise, consistent and readable descriptions. Comments on analytical information can be added wherever required. This computer-oriented approach allows rapid and varied manipulation of data to provide a variety of useful output, such as strip logs, cross sections and isopach maps. Consequently, the use of Geolog, in addition to providing a base for uniform quality of data collection, helps in the rapid appraisal of problems related to correlation and resource-reserve estimation for coal seams.

36701 **Review of the ecology of Upper Carboniferous plant assemblages with new data from Strathclyde.** Scott, A.C. *Palaeontology;* **20**: 447-473(May 1977).

Previous studies on Upper Carboniferous floral Palaeoecology are reviewed and relationships between fossil plant assemblages, depositional environments, and contemporaneous plant communities are discussed. A point-quadrat sampling technique was applied to a quantitative study of Plant horizons in a "roof shale" of a thin coal below Skipsey's Marine Band (Westphalian B) at a locality near Annbank. Strathclyde. This study has shown that the number and percentage cover of "drifted" and in-situ species varies up the Succession. Changes in the depositional environment from swampy flood plain to wear channel alluvial discharge, interpreted from the lithofacies, are thought to account for these differences by affecting the quantity of plant material deposited and by incorporating a variety of "Plant Communities" to yield different "Fossil Plant Assemblages".

36702 **Assessment of Canadian peat as an alternative fuel for power generation.** Spearman, A. Montreal; Montreal Engineering Co. (1977). 207p.

The study presents existing information and assesses the peat reserves across Canada as an alternative source of fuel for power generation. The technology and economics of harvesting and burning peat is reviewed. Capital and operating cost estimates for peat-fired power plants and for peat harvesting and its transport to the power plant are given. Environmental and socio-economic effects of peat harvesting and utilization for power generation are discussed. Conclusions are drawn and recommendations made.

36703 **Metamorphism of coals from Prokopyevsk-Kiselev deposit in Kuzbass.** Proskuryakov, A.E.; Stankevich, A.S. *Geol. Geofiz.;* No. 12, 87-92(Dec 1976). (In Russian).

The peculiarities in altering metamorphism of Prokopyevsk-Kiselev coal deposit have been made more accurate. It was found that the cross-striking metamorphic structures vary inhomogeneously while corresponding irregularly to tectonic structure of the area under discussion. The change in carbonification over the bedding depends on inclination angles of the fold hinges as well as the grade of coal metamorphism. The interrelation has been established between the above parameters. It has been found by measuring metamorphic structures over their strike that coals along the hinges of the main folds of a bed are isometamorphous. Isometamorphism of coals at the hinges in constant irrespective of the depth they were subsided or raised from the recent surface. This confirms the lack of the postinversive metamorphism. Metamorphism varies over the dipping beds as a function of carbonification of the deposits. The highest change in the refractive indices for vitrinites have been established for coals of middle grade of metamorphism lying at 100 m depth.

MINING

REFER ALSO TO CITATION(S) 36624, 36673, 36675, 36677, 36678, 36680, 36683, 36686, 36687, 36688, 36689, 36690, 36691, 36692, 36693, 36694, 36695, 36736, 36737, 36738, 36739, 36743, 37895

36704 (CONF-7706107—) **Proceedings of the seventy-third regular meeting of the Rocky Mountain Coal Mining Institute.** (Rocky Mountain Coal Mining Inst., Denver, Colo. (USA)). 1977. 136p. Mountain Coal Mining Institute, Denver, CO.

From 73. meeting of the Rocky Mountain Coal Mining Institute; Vail, CO, USA (26 Jun 1977).

The 73rd regular meeting of The Rocky Mountain Coal Mining Institute was held at Lionshead Village, Vail, Colorado, June 26-9, 1977. Ten papers have been entered individually into EDB and ERA, including one also entered into EAPA. The topics covered include papers related to surface and underground mining of Western coal deposits as follows: US ERDA's programs related to lignite and other low rank coals, longwall mining (comparative evaluation, mining equipment), simulation and mathematical models for surface mining, land reclamation after surface mining in this arid region, current mining development in Wyoming, hydraulic transport of coal from underground, status of a coal gasification project and a paper on the statistics of metallurgical coal supply and demand including forecasting to 1985. (LTN)

36705 (CONF-7710109—, pp 136-175) **Surface coal mine evaluation and equipment selection.** Morey, P.; Draffin, C.W. 1977.

From 5. symposium on surface mining and reclamation; Louisville, KY, USA (18 Oct 1977).

In Fifth symposium on surface mining and reclamation.

Large-scale surface coal mining will play a key role in meeting the future needs of the United States, especially in affecting the costs of coal conversion and advanced combustion processes being developed by the U.S. Energy Research and Development Administration (ERDA). Fluor Utah, Inc., with Bonner and Moore Associates, Inc. as subcontractor, was contracted by ERDA to study the costs and problems of large-scale surface coal mining. This project resulted in a series of computer models that can be used by the industry in mine planning and analysis. Two types of models were developed: detailed simulation models, which provide detailed information on mining systems and equipment to assist in mine design and equipment selection; and broad models, which provide a first-order evaluation of deposits and new ventures for an entire mining complex. The purpose of this paper is to exemplify the capability of the detailed simulation models to effectively size mine equipment to production demand and to perform a comprehensive economic

analysis of a surface coal mine project. The ultimate method of continued public access to the models has not been decided.

36706 (CONF-7710109—, pp 176-183) **Surface mining coal on steep slopes: back-to-contour demonstration.** Curry, J.A. (Tennessee Valley Authority, Norris). 1977.

From 5. symposium on surface mining and reclamation; Louisville, KY, USA (18 Oct 1977).

In Fifth symposium on surface mining and reclamation.

The Tennessee Valley Authority has had a long-term interest and concern for the problems of coal surface mining. Through the years the Agency has undertaken extensive efforts to help find better and more effective mining and reclamation techniques. Since 1965 TVA has had the unique opportunity to test developing technologies through its work with suppliers complying with reclamation provisions included in coal purchase contracts. As part of the Agency's contribution, in 1971 the TVA Board of Directors gave its staff the assignment of undertaking the first large scale, carefully documented test of "back-to-contour" mining on steep slopes (using revenue from power sales). The objective was to determine costs, to assess potential impact, and to help eliminate uncertainties over this developing mining technique. The Board directed that detailed records be kept and the findings published for the benefit of all interested parties. What is shown most clearly by the analysis is that incremental mining costs over conventional mining systems revolve largely around the overburden handled by truck. The report also deals with the questions of potential production loss, equipment and financial constraints, regional production shifts, and resource recovery aspects.

36707 (CONF-7710109—, pp 184-192) **Mountain-top removal as applied to multiple-seam mining.** Stevens, C.A. (Falcon Coal Co., Inc., Jackson, KY). 1977.

From 5. symposium on surface mining and reclamation; Louisville, KY, USA (18 Oct 1977).

In Fifth symposium on surface mining and reclamation.

The purpose of this paper is to discuss mountain-top removal as it applies to multiple-seam mining. Three methods of mountain-top removal will be examined and discussed relative to their application, advantages and disadvantages. A highly technical discussion will be avoided. The three methods to be discussed are: (1) the progressive method, (2) the area method, and (3) the cross-ridge method. Regardless of the method, there is one item, however, that is essential at nearly all mountain-top removal sites—that is the hollow fill. A suitable area must be available for disposal of the mountain top. This area most often is found, as its name suggests, in an adjacent hollow below the elevation of the mine site. A hollow fill can be built in two ways. The spoil may be dumped from the top or final elevation, or it must be placed in compacted layers beginning at the bottom of the fill. The industry and many highly qualified engineers favor top dumping, which has many advantages. Among these are: (1) the spoil segregates itself and forms a natural rock drain near the bottom; (2) water does not collect within the fill; (3) this method is more economical; (4) less equipment and supervision are required; and (5) less energy is consumed in the mining process.

36708 (CONF-7710109—, pp 193-224) **Surface mine haul road design to promote safe and efficient haulage.** McClain, P.M. 1977.

From 5. symposium on surface mining and reclamation; Louisville, KY, USA (18 Oct 1977).

In Fifth symposium on surface mining and reclamation.

Surface mine productivity is dependent on the ability to remove unwanted material to reach a desired product. This process, in most surface mines, is achieved through a cooperative effort on behalf of the excavator and its supporting haulage unit. Inefficiency on the part of either machine, therefore, translates to a reduction in productivity overall. Recognition of this fact makes it easy to understand continued development of larger and more powerful haulage equipment. It is essential to realize, however, that any system is only as good as its weakest link. Many times an inadequately designed and constructed haul road constitutes this "weak link", and reduces the efficiency of material removal to a point where all unit operations from overburden removal to find reclamation are restricted. Thus, neglecting to provide a good haul route will eventually force operating costs upward and influence overall mine economics. More important than economics, however, is the intangible aspect of road design; safety. No amount of money can compensate for loss of life. With the haul road designer lies responsibility for the safety of every equipment operator. Every effort must be made to ensure development of a roadway which allows no sacrifice of safety in the interest of economics.

36709 **Some opportunities in teleoperated mining.** Palowitch, E.R.; Broussard, P.H. (US Bur of Mines, Pittsburgh Min and Saf Res Cent, Pa). *Mech. Mach. Theory;* **12**: No. 5, 493-501(1977).

The need for increasing coal production and work productivity while improving the health and safety of the coal miner presents some interesting challenges and opportunities for teleoperation. Systems available for mining coal are described briefly in terms of four subsystems: Fragmentation, materials handling, ground control, and environmental control. The need for automation systems, their requirements, and the state-of-the-art explored. Technologic deficiencies of longwall mining--the system having the highest potential for full automation--are discussed.

36710 **Process for forming a coalate solution in-situ.** Drinkard, G.; McLaughlin, W.A. (to Shell Oil Co.). US Patent 4,076,078. 28 Feb 1978. Filed date 23 Aug 1976. 10p.

This invention is a process for mining an underground formation of coal having high oxygen content by contacting the coal with a heated basic aqueous solution for a time sufficient to dissolve at least a portion of the coal formation to produce a coalate. Periodically or continuously, some of the dissolved material is removed to facilitate or improve access to the coal formation. The dissolved coal or coalate is then treated with a regenerating agent to recover basic aqueous solution from the coalate.

36711 **Mine roof support assemblies.** Harmsma, G. (to Gewerkschaft Eisenhutte Westfalia). US Patent 4,073,151. 14 Feb 1978. Priority date 5 Feb 1976, German, Federal Republic of (F.R. Germany). 6p.

A mine roof support assembly comprises a pair of adjacent mine roof support units and apparatus for guiding and aligning these units. Each of the units has a floor sill and telescopic props for bracing against the roof of a mine excavation. Shifting ram means are provided for displacing the units in the direction in which the working face advances. The guiding and aligning apparatus comprises two telescopic guide rods which are pivotally connected to the units. Each guide rod is constituted by a springless, non-hydraulic piston-and-cylinder device. The two guide rods are inclined at an acute angle to one another in such a way that, when the units are positioned side-by-side, one of the guide rods is completely retracted and its axis is perpendicular to the direction in which the units are displaced, and, when one of the units has been displaced by the shifting ram means relative to the other unit, the other guide rod is completely retracted.

36712 **Suspended valve control device.** Welzel, J. (to Hermann Hemscheidt, Maschinenfabrik). US Patent 4,073,150. 14 Feb 1978. Priority date 22 May 1976, German, Federal Republic of (F.R. Germany). 2p.

A multiple valve control device is suspended by means of a chain or other flexible supporting means such as a cable from a rod or bar carried on a walking mine-roof support frame, the chain or other flexible supporting means being movable with and/or along the rod or bar and being adjustably hooked or otherwise releasably fastened in any one of a line of recesses in a balance beam secured to the control device.

36713 **Mine roof support assemblies.** Kauter, H. (to Gewerkschaft Eisenhutte Westfalia). US Patent 4,073,149. 14 Feb 1978. Priority date 18 Dec 1974, German, Federal Republic of (F.R. Germany). 6p.

A mine roof support assembly is disclosed which has a stowage or goaf screen lining pivoted to a floor-engaging sill structure and a piston and cylinder unit arranged between the sill structure and the screen to effect pivoting of the screen. A roof bar is pivotably connected to a bell-crank lever which is itself pivoted to the screen and a stiff rod is pivotably connected to the bell-crank lever and to the sill structure. The rod and bell-crank lever form a control linkage which exerts a compensating effect on the roof bar as the screen is pivoted to move the bar against or away from the roof, so that the bar maintains in horizontal orientation while the front end of the bar moves along a vertical line.

36714 **Interconnexion of surface and underground water resources in southeast Durham.** Cairney, T.; Hamill, L. *J. Hydrol.;* **33**: No. 1/2, 73-86(1977).

The superficial geology of the Skerne catchment, Co. Durham comprises thin limestone gravels and glacial clays, underlain by the Magnesian limestone, which is itself underlain by coal measures stata. Water from mines in the coal measures was pumped into the Skerne River on a dialy cycle until September 1974. The mine-water discharges have an identifiable curve form, and the data from three gauging stations were used to determine losses from the river. It was previously thought that the river and the Magneisian limestone aquifer were hydraulically unconnected, but the authors were able to show that exploitation of the aquifer is inducing recharge through the bed of the river, and that up to 37% of the flow of the river is lost in this way.

36715 **Basis for the development of the coal industry of the USSR.** Bratchenko, B.F. *Nat. Resour. Forum;* **1**: No. 1, vp(Oct 1976).

Paper outlines the historical development of the industry and examines the policy of concentration of production, priorities for research, and future plans for the industry. An assessment of produc-

tivity, management methods, training and education programmes, safety measures, and conditions of work is included.

36716 Notes on the application of the finite element method to mining research. Scoble, M.J. *Univ. Nottingham Min. Dep. Mag.;* **28**: 57-67(1976).

A suite of finite element computer programs, developed at the University of Nottingham, has been applied to problems in mining subsidence, heat flow around mine roadways, gas flow in coal seams, rock bolt strength predictions, rock slope stability, temperature predictions along survey lines, and drill bit failure analysis. Details of each of these applications are given.

36717 World mining and metals technology. Volume 1. Weiss, A. (ed.). New York; American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc. (1976). 577p. (CONF-7609165—P1).

From Proceedings of the joint MMIJ-AIME meeting; Denver, CO, USA (1 Sep 1976).

Thirty-three papers presented at the meeting on geology, limestone, coal mining, ocean exploration, solution mining, minerals processing, and metals mining are included in Volume I. A separate abstract was prepared for each of five papers. (JRD)

36718 Development of self advancing support for upper face in longwall slicing system at Miike Colliery. Maemura, S. (Mitsui Coal Mining Co. Ltd., Tokyo). pp 191-208 of World mining and metals technology. Vol. 1. Weiss, A. (ed.). New York; American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc. (1976).

From Proceedings of the joint MMIJ-AIME meeting; Denver, CO, USA (1 Sep 1976).

See CONF-7609165—P1.

Miike Colliery of Mitsui Coal Mining Company, the biggest and oldest coal mine in Japan, is producing a quarter of the national coal production, about 5.2 million tons of clean coal annually and almost a half of which is now being mined under the "Slicing Mining System." The slicing system is a mining method to mine a thick coal seam dividing it into two faces, upper and lower. Its history started nearly 20 years ago. However, the all-around modernization of this system has made little progress up to recent years, while mining methods for single longwall faces has made a remarkable progress together with the improvements in mining machineries, self advancing supports and so on. The reason was that the tremendous difference in adaptabilities of mechanized face equipments existing between the upper and lower faces has made it very difficult to increase the total production capacity of slicing system. A satisfactory slicing system has evolved by applying a combination of shield type self advancing supports and double ranging drum cutter at both faces. The efficient, safe, and improved slicing system has been basically established for the present. The transition of the combination of self advancing supports and mining machines, is described along with the development of shield type self advancing support for upper face and artificial roof material.

36719 Development of Yubari New coal mine. Nishimura, S. (Hokkaido Colliery and Steamship Co. Ltd., Tokyo). pp 219-244 of World mining and metals technology. Vol. 1. Weiss, A. (ed.). New York; American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc. (1976).

From Proceedings of the joint MMIJ-AIME meeting; Denver, CO, USA (1 Sep 1976).

See CONF-7609165—P1.

The achievements to date at the British Columbia mine of Kaiser Resources Ltd. is outlined. Almost one million raw short tons (855,000 metric tonnes) are now produced per year from a single minitor operation working 15 short shifts per week. Progress has been made in reducing the angle at which coal will flow in flumes by modifying the shape and the plastic linings. Improvements have been made in transporting coal from heading machines, and in the design of the present and future coal:water circuits. The development of hydraulic mining is still young and many improvements are being made.

36720 Progress in hydraulic mining of coal. Parkes, D.M. (Kaiser Resources Ltd., Vancouver, B.C.). pp 209-218 of World mining and metals technology. Vol. 1. Weiss, A. (ed.). New York; American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc. (1976).

From Proceedings of the joint MMIJ-AIME meeting; Denver, CO, USA (1 Sep 1976).

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36721 Transport of products-accessories for armoured conveyors-distribution of wall-ties: simplified model adaptable to different kinds of powered support. *Publ. Tech. Charbon. Fr., Inf. Tech.;* No. 5, 281-290(1976).

Defects in holding devices for armoured conveyors led to the developments of a device of minimum dimensions, adaptable to all types of armoured conveyor in use and to Westfalia K 1-2, K2 and Marrel 4 props. The device was first used in 1973, and has proved satisfactory. The spacing of wall ties is varied according to the slope of the armoured conveyor.

TRANSPORT AND HANDLING

REFER ALSO TO CITATION(S) 36605, 37550, 37878

36722 (NP—22938) **Ozarks region energy alternatives study. Working Paper VII. Coal transportation.** (Resource Planning Associates, Inc., Cambridge, Mass. (USA)). Apr 1977. 65p. Regional Commission, Little Rock, AR.

This Working Paper examines the probable coal transportation patterns in the Ozarks Region through 1985. Estimates of potential coal traffic to and through the Ozarks Region by rail are made for major rail routes, and the potential advantages and disadvantages of rail vs. slurry pipelines are examined. Environmental impacts of coal transportation are identified.

36723 Nonionic surfactants: swelling inhibitors for high-clay coals. Dolina, L.F. *Koks Khim.;* No. 6, 13-16(Jun 1977).

Of various surfactants tested, the most effective was an acyclical type, Syntanox 920, optimum concentration being 0.005%. Swelling was greatly reduced and retarded by this particular agent as compared with other less commercially popular brands. Residual amounts of the reagents in the recycle water at preparation plants can reduce the swelling propensity of r.o.m. coal constituting the washery feed. Cation-active surfactants increase ash in the refuse, provided that the reagent has been adequately and evenly distributed in the flotation cell. Surfactants can also be sprayed onto dewatering filters, preferably downstream of centrifugal thickeners.

36724 Formation and filtration of flocs from coal slurries. Singh, B.K. *Glueckauf-Forschungsh.;* **38**: No. 3, 115-120(Jun 1977).

The size and size distribution of flocs are greatly influenced by the type and concentration of the flocculant coal and dirt particles behave differently in this respect. The pH and the concentration of electrolytes also influence flocculation, by changing both the surface properties of the solid material and the effectiveness of the flocculant. The relationship between the sedimentation time and the filtration rate depends on the concentration and type of flocculant. Optimum pH values for various conditions are tabulated. When an anion-active flocculant is added to a coal-dirt mixture in an alkaline medium, selective flocculation occurs; this can be used to improve the separation of slurries.

36725 Screening equipment for modern preparation plants. Mandrella, H. *Glueckauf;* **113**: No. 10, 506-509(19 May 1977).

Types of screens which can be used in coal preparation plant are discussed. Double disbalanced screens are being used increasingly because they combine the advantages of resonance and rotary screens.

36726 Powder handling control: weighty developments. Wood, R. *Process Eng.;* 72-73(May 1977).

Some weighing equipment which was displayed at the Powtech exhibition is described.

36727 Travelling bed convection dryer for coals. Wasilewski, P. *Koks Khim.;* No. 3, 6-9(Mar 1977).

Effective dryers must dry the material in a compact space within a short period of time, using the minimum amount of heat on a continuous basis, and at the same time prevent waste gases entraining useful material. In the traveling bed dryer, the drying agent passes through the bed of material and removes the moisture. Turbulent conditions are maintained by the constant reversals and changes of direction of the drying gas. In the convective mode, there is sustained intimate contact with the material being dried and the time expended is much less. The fact that the gas velocity drops sharply on escaping from the coal being dried prevents entrainment of the coal particles. The paper describes a set-up in detail and underlines the importance of dimensions and flow rates, with supporting formulae.

36728 From the preparation of coal to the preparation of other materials. Educational thoughts. Moiset, P. *Ann. Mines Belg.;* 1027-1034(Dec 1976).

The author describes his teaching experience in the domain of the preparation of ores and other materials. It appears essential to him to assemble in one unique discipline the procedures of concentration, separation and purification using only physical methods. He considers coal, ores and other matter as binary mixtures from which one tries to separate the constituents without modifying them. He has been aided in that field by work carried out by CERCHAR before and after World War II. Firstly he studies the particular properties of the constituents of a binary mixture which makes him able to define the notion of perfect industrial separation. He shows the possibility of predetermining the results of gravimetric concentrations. Finally, the last step of this generalisation is made by the application of material preparation procedures. As a conclusion, he explains why he had to conceive of the teaching of the concentration techniques themselves. He shows the timetable of the industrial mineralogy lectures at the Faculte Polytechnique de Mons.

36729 Calculation of the profile of the sediment forming in an inclined pipe of a slurry-conveying system when flow stops. Kril, I.S. *Fluid Mech. - Sov. Res.;* **5**: 43-52(Mar 1976).

A set of differential equations describing the deposition of fine solids in an inclined slurry-transport pipe is derived. An approximate calculation of the profile of the solid mass forming at the bottom of this inclined pipe when the pump is stopped is given.

36730 Determination of theoretical cleanability indices for coal slurry. Kuzbatov, V.P. *Coke Chem., USSR (Engl. Transl.);* No. 3, 6-7(1976).

Wet fines were oiled in a mixer, the mixture diluted and the pulp charged to a flotation machine. The concentrate was skimmed off, dewatered in vacuo and dried, and the oil was removed by benzene extraction. Pre-treated wet fines could be separated much more efficiently in this way, giving lower ash and greater ash removal in the flotation tailings.

36731 Change in the electric fields in spontaneously heating heaps of solid. Obukhov, N.K. *Solid Fuel Chem. (USSR) (Engl. Transl.);* **10**: No. 4, 65-69(1976).

Experiments have confirmed an increase in electrical fields in coal heating in situ. A theoretical basis for this phenomenon, which involves electrochemical theories of corrosion and fuel elements is provided.

36732 Some new coal preparation developments in the United Kingdom. Jenkinson, D.E. *Deco Trefoil;* **39**: No. 75-1, 7-14(1975).

The steps being taken to improve the efficiency of coal preparation are described, and some of the problems are described. Among the developments discussed are vibrating rotary screens, a Rotating Probability Screen that permits treatment of damp material, the use of flotation for the removal of fines and for improved "handleability", the adoption of polyurethane for impellers and diffusers of large flotation machines, tests on various ways of reducing the moisture content of filter residues, the use of deep-settling cones to provide thickened products of low water content, the Bretby Autex flocculent mixer (which helps to reduce the cost of flocculent in thickening and filtration), automation of plant operation, and the National Coal Board's system for continuous sampling of a stream of coal and determination of its ash content by continuous x-ray analyzer.

COMBUSTION

REFER ALSO TO CITATION(S) 36597, 36646, 36652, 36655, 36697, 37235, 37251, 37985

36733 (FE—2288-19) **Direct sampling and characterization of gaseous species responsible for fireside corrosion in fossil fuel-fired systems. Annual report: Phase I, April 1, 1976—July 30, 1977.** Greene, F.T.; Beachey, J.E.; Milne, T.A. (Midwest Research Inst., Kansas City, Mo. (USA)). 22 Aug 1977. Contract EX-76-C-01-2288. 57p. Dep. NTIS, PC A04/MF A01.

A molecular beam mass spectrometric sampling system for the study of minor species in coal dust-air flames was designed, constructed and tested. Interferences due to ionization by particulates and metastable species were eliminated, and the system capability was demonstrated by sampling alkali metal and other species at parts per million levels from coal dust-air flames. Limited attempts were also made to improve on current coal dust feeder and burner designs.

36734 Grimethorpe colliery test rig. *Chem. Eng. (London);* No. 320, 345(May 1977).

The principles of fluidized bed combustion are briefly discussed and details are given of the fluidized bed test facility which is being built at Grimethorpe.

36735 Recent developments in fluidised bed combustion and potential benefits to the coal industry. Gibson, J. *Min. Eng. (London);* **136**: No. 194, 599-606(Jul 1976).

The development of fluidized bed combustion and its potential application to power generation in conventional and advanced cycles are described. Its use in substitution for oil-firing in compact new and existing boilers and furnaces is possible following on the successful operation of a 600 kW conventional hot water boiler and a 1.2 MW horizontal shell type steam-raising boiler. In addition to boilers, examples are given of the adaption of fluidized combustion to industrial and agricultural drying processes and to the safe disposal of colliery, municipal and industrial waste materials. Economic assessments confirm advantages over conventional coal burning systems of lower capital and running costs, greater operational amenity and the capacity to reduce emissions to acceptable environmental requirements. The benefits will be to keep coal in a favourable position in the market place, to extend coal resources by bringing what were regarded as inferior coals into economic use and to extend the potential life of collieries.

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 36629

36736 (CONF-770136—, pp 12p, Section 7, Paper 1) **Coal development financing by commercial banks.** Wilson, W.W. (Continental Illinois National Bank and Trust Co., Chicago). 1977.

From Coal production, use and financing conference; Washington, DC, USA (25 Jan 1977).

In Conference on coal production, use and financing.

Problems in financing coal mines are discussed. Some complications with taxes and with regulated utilities who own coal mine subsidaries are mentioned. (LTN)

36737 (CONF-770136—, pp 26p, Section 7, Paper 3) **Overview on financing.** Lee, C.H. Jr. 1977.

From Coal production, use and financing conference; Washington, DC, USA (25 Jan 1977).

In Conference on coal production, use and financing.

External financing of the order of $10 to $15 billion may be required by the coal industry to finance the expansion called for by Project Independence. Possible methods of financing are discussed, especially with respect to methods which might be used by companies of different size. (LTN)

36738 (CONF-770136—, pp 6p, Section 7, Paper 4) **Leveraged buy-out coal mine financing alternatives.** Wang, P. 1977.

From Coal production, use and financing conference; Washington, DC, USA (25 Jan 1977).

In Conference on coal production, use and financing.

The following alternative methods of financing a leveraged buy-out coal mine situation are compared: Take or pay long term contract, production payment carve out, advance coal payments and tax shelter arrangements. These possibilities are considered with respect to: The buyers objectives, the sellers objectives, cash flow constraints, availability of funds and impact of financing on operations and on expansion possibilities. (LTN)

36739 (CONF-770136—, pp 39p, Section 8, Paper 1) **Coal option, constraints to growth: issues, impacts, solutions.** Gambs, G.C. (Ford, Bacon, and Davis, Inc., New York). 1977.

From Coal production, use and financing conference; Washington, DC, USA (25 Jan 1977).

In Conference on coal production, use and financing.

To summarize the coal situation, the U.S. has large and excellent reserves of coal which the mining industry is capable of mining from a technical standpoint. However, due to Government restrictions of various types, the coal industry is not being allowed to perform its role in helping to supply its share of the total energy mix which this country needs to survive as an industrial nation. Unless this is recognized in Washington and corrective action is taken to remove these obstacles and restrictions, there can be no hope that the U.S. coal industry can reach the production goals which have been set.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 36697

36740 Health hazard of coal power. *New Sci.;* **74**: No. 1057, 693(23 Jun 1977).

A spokesman for the U.S. National Institute for Occupational Safety and Health has said that there could be a large increase in industrial accidents and disease if coal is used to solve U.S. energy

problems. This increase would be smaller if the coal was produced by surface mining, but there are health hazards connected with coal cleaning and conversion. The spokesman added that the health and safety problems were not insurmountable.

36741 Portable resuscitation equipment. Young, R.F. *Protection (London);* **13**: No. 10, 50(Dec 1976).

The paper briefly describes resuscitation equipment, used by the UK National Coal Board, and the regulations governing its use.

36742 Statistics of accidents during 1975 in coal mines and other establishments supervised by the Administration des Mines. Medaets, J. *Ann. Mines Belg.;* 1087-1112(Dec 1976).

Paper notes that between 1974 and 1975 the number of accidents in Belgian coal mines fell by 8.5 percent and that accidents caused by collapse and roof fall are by far the most important (38.1 percent); the second place is taken by cutting machines, loaders, etc (18.9 percent). Author examines the frequency and the seriousness of underground and surface risks and discusses the reporting of accidents by the Administration des Mines, fatalities, and analysis of serious accidents by mine and by the nature of the wounds. Fatal accidents in different types of mines, both underground and surface, are compared.

REGULATIONS

REFER ALSO TO CITATION(S) 36679

36743 Surface mining control and reclamation act of 1977. Hearings before the Subcommittee on Energy and the Environment of the Committee on Interior and Insular Affairs, House of Representatives, Ninety-Fifth Congress, First Session on H.R. 2, held in Washington, D.C., February 8, 16, and 22, 1977. Serial No. 95-1, Part II. Washington, DC; Committee on Interior and Insular Affairs (1977). 602p. GPO.

H. R. 2 provides for cooperation between the Secretary of the Interior and the states with respect to the regulation of surface coal mining operations and the acquisition and reclamation of abandoned mines, and for other purposes. Rep. Morris K. Udall presided over the first two sessions and Rep. John Seiberling over the last session. The first 41 pages of the Feb. 8 hearing is devoted to the testimony and "statement for the record" of Sec. of the Interior Cecil D. Andrus. Afterwards are 17 additional statements for the three hearings (state officials, mining association officials, panels of coal company officials, etc.). An appendix consisting of 9 letters, 2 reports, and one resolution completes this collection.

PETROLEUM

REFER ALSO TO CITATION(S) 36595

GEOLOGY AND EXPLORATION

36744 Peculiarities of the reservoir rocks of the Samgori-Patardzeuli oil deposit. Aslanikashvili, N.A. *Soobshch. Akad. Nauk Gruz. SSR;* **88**: No. 3, 621-624(Dec 1977). (In Russian).

Some discrepancy between the high well discharges and low indices of open porosity in Samgori-Patardzeuli oil deposit is observed. Electron microscopic studies of microcrystalline surface of zeolitized tuffs point to the presence of microspores which, against the background of high thermobaric parameters may facilitate improvement of the filtration properties of the reservoir rocks.

36745 Conditions for the formation of hydrodynamic oil traps in the Al'bskii deposits of the Chernolesskii Depression (Eastern Precaucasus). Burshtar, M.S.; Nazarov, D.A.; Gurova, A.D. (All-Union Scientific-Research Geologicla Surveying Inst. for Petroleum, Moscow). *Izv. Akad. Nauk SSSR, Ser. Geol.;* No. 9, 146-153(Sep 1976). (In Russian).

With the Al'bskii complex of the Chernolesskii Depression of the Eastern Precaucasus as an example it is shown that filtered, water-pressurized systems of young platforms, which are characteristic for terrigenic sedimentary complexes, the consolidation of which continues in the present era, are favorable media for the formation of hydrodynamic oil traps. It was established that at hydraulic gradients of 2.5 to 617 m/km the hydrodynamic traps and the associated oil deposits are linked in particular with positive structural forms (closed and not closed). The dimensions and shape of the hydrodynamic traps (and consequently also of the oil deposits) depend on the morphology and amplitude of the positive structural forms, and also on the position with respect to the front of sedimentogenic water flow. Since filtered, water-pressurized systems are widely developed in young platforms, it would be expected that a significant number of hydrodynamic traps would be found within their boundaries, which would be linked first with pereclinals and wings of structures of the free type, and also with structural headlands (promontories). The search for hydrodynamic traps is reduced to finding parts of a stratum-collector, which is overlain with an impenetrable covering and is contoured on a plot by closed, equipotential lines of oil of minimal values. 1 table, 6 figures, 5 references. (SJR)

36746 Ways of determining the effective thickness in complex anisotropic series of the Lower Sarmate. Fedorovich, G.P.; Glagola, D.D. pp 83-88 of Obrabotka i interpritatsiya rezul'tatov geofizicheskikh issledovanij. Kiev; Tekhnika (1976). (In Russian)

A graphical method for determining the sand coefficient for anisotropic strata of terrigeneous lower Sarmatian deposits in the pre-Carpathian depression from data obtained in many geophysical methods presented in the form of relative differential values is considered. The possibility of closely controlling the manually determined effective thickness of the anisotropic collector parts is discussed.

36747 Estimation of criteria of boundary values of geophysical exploration parameters for the reservoirs of the Prikarpatje deposits. Gritsishin, V.I. pp 115-118 of Obrabotka i interpretatsiya rezul'tatov geofizicheskikh issledovanij. Kiev; Tekhnika (1976). (In Russian)

The results of an analysis of the petrophysical and geophysical parameters made for the purpose of establishing the boundary values of the geophysical parameters in the identifaction of rocks of Paleogene origin in the Pre-Carpathian region in collectors and noncollectors are presented. The values of gravimetric clay and carbonate and the dual parameters Isub(y) and Isub(ny) and the relative parameter ΔUsup(rel)sub(sp) are given. Methods for determining and using them for identifying collectors in a borehole section are described.

36748 Relationship between the composition of petroleum and bitumoids in the Pripyat Depression intersalt deposits and the extend of organic matter catogenesis. Laput, V.A.; Beskopyl'nyi, V.N.; Garmasheva, L.F. (Belorussian Scientific-Research Geological-Exploring Inst., Minsk). *Dokl. Akad. Nauk BSSR;* **20**: No. 12, 1110-1112(1976). (In Russian).

The very concise interconnection between the composition of petroleum and bitumoids and the extent of decaying organic matter catagenesis is demonstrated by the reflectivity of vitrinite. As the degree of metamorphosis increases (from stage B_1 to G) the petroleum and bitumoids usually become quantitatively richer in methane hydrocarbons and solid paraffins, and poorer in resin, asphaltene, and sulfur content. Regions for petroleum and gas exploration and survey are recommended accordingly.

DRILLING AND PRODUCTION

REFER ALSO TO CITATION(S) 36829, 36861, 37205

36749 (BERC—78/1) **Contracts and grants for cooperative research on enhanced oil and gas recovery and improved drilling methods. Progress review No. 13, quarter ending December 31, 1977.** Linville, B. (ed.). (Department of Energy, Bartlesville, Okla. (USA). Bartlesville Energy Research Center). Mar 1978. 140p. Dep. NTIS, PC A07/MF A01.

Short summaries of technical progress made in the following research areas are presented: micellar-polymer flooding; supporting research for micellar-polymer flooding; improved waterflooding; supporting research for improved waterflooding; carbon dioxide injection; supporting research for carbon dioxide flooding; thermal/heavy oil recovery; supporting research for thermal/heavy oil recovery; enhanced gas recovery by massive hydraulic fracturing; eastern gas shales; and improved drilling methods.

36750 (CONF-770440—, pp 403) **How alternate stages of pad fluid and acid improve leakoff control during fracture acidizing treatments.** Miller, B.D.; Coulter, A.W. (Dow Chemical U.S.A., Tulsa, OK). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

Improvements in leakoff control in deep penetrating fractures have been accomplished by the use of a viscous, nonreactive fluids and viscous, nonreactive fluids containing fine sand when used in alternate stages with acid. Macro examination of hairline fracture vugs and large pores and examination under the scanning electron microscope coupled with laboratory fluid loss data explain how the pad fluid and pad fluid containing fine sand can control fluid leadoff. Another facet of this investigation has been a study and analysis of

pressure variations during fracture treatments. This contributes further evidence of the influence of a peakoff control mechanism. These data, although possibly subject to different interpretation, can be shown to confirm the premise of leakoff control by inert pads sandwiched between stages of acid while acid fracturing.

36751 (CONF-770440—, pp 404-414) **ERDA's enhanced oil recovery program.** Ball, J.S. (Energy Research and Development Administration, Bartlesville, OK). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

The ERDA program has placed Enhanced Oil Recovery as one of the near-term highest priorities. A goal of 500,000 barrels of oil per day from EOR by 1985 has been set. To respond to this, cost-sharing demonstrations of technology developed by industry have been commissioned. Their purpose is to share technology by making all data from these projects available industry-wide. The techniques under consideration are micellar polymer flooding, improved waterflooding (polymer or caustic flooding), carbon dioxide flooding, and thermal recovery. The Bartlesville Energy Research Center is now monitoring five micellar polymer demonstrations, one polymer demonstration and two thermal recovery projects, which are valued at over $80 million. Other ERDA organizations are monitoring an additional micellar polymer demonstration, a carbon dioxide flood, two improved waterfloods, and two thermal recovery projects. A program of directed university research involves projects at the University of Texas, West Virginia University, Carnegie-Mellon University, Northwestern University, Penn State University, University of Houston, Tulsa University, and Stanford University. A re-study of the management plan has resulted in a new plan with somewhat different priorities based on the possibility of achievement by 1985. The highest priority is given to carbon dioxide flooding and steam drive with special attention to specific restraints such as emissions control.

36752 (CONF-770440—, pp 696-706) **Pressure transient testing of hydraulically-fractured wells.** Ramey, H.J. Jr.; Barker, B.; Arihara, N.; Mao, M.L.; Marques, J.K. (Stanford Univ., CA). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

A recent study of the behavior of hydraulically-fractured wells by Gringarten, Ramey, and Raghaven produced a log-log type curve which may be used to find apparent fracture lengths and formation permeability under the assumption that the fracture permeability is infinitely great. Use of this type curve has frequently produced short apparent fracture lengths. One of several probable reasons for this result is that real fractures have a finite permeability. A study of the behavior of fractured wells for finite fracture permeability was made using both finite element calculations and a new potentiometric model. Results of this study indicate that previous conclusions that fracture permeabilities 100 times the formation value are essentially infinite fracture permeability are not correct. Finite fracture permeability is shown to be capable of reducing apparent fracture lengths by many orders of magnitude. Other factors also may affect apparent fracture lengths.

36753 (ORO—5302-18) **Tertiary oil recovery by CO_2 injection. Quarterly report, July—September 1977.** Conner, W.D. (Columbia Gas Transmission Corp., Charleston, W.Va. (USA)). Mar 1978. Contract EF-76-C-05-5302. 24p. Dep. NTIS, PC A02/MF A01.

The 5th Phase of the project, water injection, began on June 16, 1977, with the completion of CO_2 injection and continued throughout the current quarter. Total water injection for the period was 16,405 barrels for an average of 44.5 barrels of water per well per day. While the current rate is somewhat below that planned, it is expected that the project will be completed as scheduled. Although there were 198 hours of down time, only 30 of it was planned and that was to install a new filter system and clean the water storage tanks. The remainder of the down time was caused by power outages. Oil production for the period amounted to 6155 barrels, bringing the total oil recovered due to CO_2 injection, to 7620 barrels. While total oil production was higher than the previous quarter, it actually peaked during June and declined slightly during July and rather drastically during August. Pumping equipment was installed in well No. 4254 in the later part of July and almost immediately the oil production began declining and water production increased. Bottom hole pressures taken during the quarter indicates continued high reservoir pressures inside the pattern.

36754 (ORO—5302-22) **Tertiary oil recovery by CO_2 injection. Quarterly report, October—December 1977.** Conner, W.D. (Columbia Gas Transmission Corp., Charleston, W.Va. (USA)). Mar 1978. Contract EF-76-C-05-5302. 23p. Dep. NTIS, PC A02/MF A01.

Water injection during the 5th phase of the project continued throughout the quarter. Total injection of 16,097 barrels was approximately 300 barrels less than the previous period, although down time was 100 hours less and operating days were the same. The lower rate is directly attributable to the continually increasing reservoir pressures encountered as shown by the bottom hole pressure tests. To date no serious injection problems have occurred and the water supply continues to be adequate. Oil production continues to decline particularly in the center producer (well 4254). Total oil production for the period was 4624 barrels, bringing the total to date due to CO_2 injection to 8,155 barrels. Increases in water production along with the decline in oil production has brought the total water cut up to 63%. Other than routine servicing, no particular problems were encountered with the producing wells.

36755 (SAN—1188-2) **Williams Holding Lease, Steamflood Demonstration Pilot, Cat Canyon Oil Field. First Annual report, June 25, 1976—June 1, 1977.** Hanzlik, E.J.; Schenck, H. (Getty Oil Co., Ventura, Calif. (USA). Western Exploration and Production Div.). 1977. Contract EY-76-C-03-1188. 57p. Dep. NTIS, PC A04/MF A01.

On June 25, 1976 Getty Oil Company was awarded a cost-sharing contract from ERDA to conduct a joint steamflood pilot on the Williams Holding Lease of Cat Canyon Field in the Santa Maria Basin. The pilot program is being conducted to evaluate the efficiency and economics of the steam displacement process for future full-scale development in the Cat Canyon S1-B reservoir and similar heavy oil reservoirs. The project progress from the inception of the contract to June 1, 1977 is discussed. Included are summaries of the predisplacement activities such as cyclic steam stimulation of the pilot wells, acquisition of steam generator permits, and the results of further computer simulation studies conducted under more restrictive assumptions for field operating conditions expected for the pilot project. Discussion of the displacement phase of the project, which started in April, 1977, is divided into three sections: (1) initial pilot performance, (2) steam generator operations, and (3) thermal packer failures. Future operations are then summarized.

36756 **Sonic measurement of flow rate and water content of oil-water streams.** Alexander, J.D.; Reed, P.W. (to Continental Oil Co.). US Patent 4,080,837. 28 Mar 1978. Filed date 3 Dec 1976. 8p.

A method and apparatus are disclosed for metering water content in an oil-water system by measuring sonic velocity in a flowing oil-water mixture, thereafter to determine flow rate to provide individual oil and water rates which may then be integrated to provide oil and water volume of flow. The apparatus functions to provide continual readout of oil and water data by deriving bi-directional speed of sound through the moving medium with subsequent frequency difference processing to derive sonic velocity, flow rate measurement and subsequent integral data output.

36757 **Shear rams for hydrogen sulfide service.** Nguyen, T.X.T. (to Rucker Co.). US Patent 4,081,027. 28 Mar 1978. Filed date 23 Aug 1976. 10p.

Shear rams shearing drill pipe passing through with blowout preventers encountering hydrogen sulfide are disclosed. The ram bodies are formed of an alloy having an upper hardness level of about Rc22 and the shearing blade and drill string engaging surfaces of the rams are hardfaced with a layer of nickel-based alloys, cobalt-based alloys, and tungsten-based alloys hard enough to shear the drill pipe. The layer of alloy is thin enough to avoid peeling off in use and warping the ram bodies when being welded to them. A number of embodiments and examples of the invention is disclosed.

36758 **Oil well stimulation method.** Mohaupt, H.H. (to Kine-Tech Corp.). US Patent 4,081,031. 28 Mar 1978. Filed date 13 Sep 1976. 12p.

A method of stimulation oil well production uses a gas generating chemical charge that is placed in the oil well bore at a depth of known oil productivity where it is ignited to generate a gas pressure-volume pulse of known pressure-time characteristics and time duration, the pressure time characteristics includes a pulsating pressure for greater penetration effect.

36759 **Method for in situ combustion for enhanced thermal recovery of hydrocarbons from a well and ignition system therefor.** Howard, C.E.; Calvin, D.G.; Pitts, R.W. Jr. (to Texaco Inc.). US Patent 4,079,784. 21 Mar 1978. Filed date 22 Mar 1976. 12p.

A method for heating a well or for initiating an in situ combustion operation to recover petroleum from a well in a subterranean reservoir, a method for assembling an ignition system for the in situ combustion, and an ignition system comprises an elongated combustion chamber suspended from a hollow electrical cable which supplies both electrical means and fuel gas to the chamber. Air inlet ducts in the walls of the combustion chamber receive air from the annular space between the hollow cable and the wellbore tubing. An electrical ignitor is temporarily energized to ignite the fuel-air mixture in the air inlet cylinder. An adjacent thermocouple is responsive to a flameout for re-energizing an ignitor manually such that burner operation is interrupted only momentarily.

36760 Oil recovery method using in situ-partitioning surfactant flood systems. Hessert, J.E.; Boneau, D.F.; Clampitt, R.L. (to Phillips Petroleum Co.). US Patent 4,079,785. 21 Mar 1978. Filed date 18 Mar 1977. 12p.

Samples of oil from a formation to be flooded are equilibrated with a series of surfactant systems comprising a petroleum sulfonate surfactant, a cosurfactant having limited solubility in water and brine. By using sulfonates having an equivalent weight within the range of 375 to 500 and using cosurfactants having a solubility in water varying from 0.5 to 20 grams per 100 grams of water, some of the mixtures will partition into two or more phases while others will not. Then a separate sulfonate-cosurfactant-brine system is made up corresponding to one of those which partitions and the system is injected into the reservoir where on contact with the oil it forms a multiphase bank.

36761 Method of and apparatus for telemetering information from a point in a well borehole to the earth's surface. Westlake, J.H.; Leach, C.H.; Ainsworth, C.L. US Patent 4,078,620. 14 Mar 1978. Priority date 10 Mar 1975, United Kingdom of Great Britain and Northern Ireland (UK). 12p.

Down-hole information from rotary well drilling operations is transmitted to a surface or remote location by the venting of drilling fluid from the interior of the drill stem into the bore hole annulus in a binary coded decimal format. A valve is caused to operate by the digital output of one or more down-hole transducers thus releasing and restoring the drilling fluid pressure in the desired sequence. A "sub" contains the necessary electronics, power supply and a motorized valve assembly. Commands from the surface to transmit information from any one of the transducers are transmitted by means of sequential pulses in a binary coded decimal format, in the drilling fluid pressure are provided by the operator by deliberately decreasing and then increasing the surface pump pressure in a sequence to which the applicable down-hole actuating means is responsive.

36762 Downhole recovery system. Hamrick, J.T.; Rose, L.C. (to World Energy Systems). US Patent 4,078,613. 14 Mar 1978. Filed date 3 Jan 1977. 14p.

A gas generator is described for use in a borehole for generating steam and other hot gases for use in recovering hydrocarbons or other fluids from underground formations. The gas generator comprises a housing forming a chamber with a combustion zone at one end and a restricted outlet at the other end. A second zone is located downstream of the combustion zone and a gas and water mixing zone is located between the second zone and the restricted outlet. The generator has a cooling annulus surrounding the chamber with passages leading from the annulus to the gas and water mixing zone. Methane is burned in the combustion zone with just enough oxygen to maintain the flame temperature below the decomposition temperature of methane to convert substantially all of the carbon to carbon monixide and to form hydrogen. In the second zone, the carbon monoxide and hydrogen are burned with an additional supply of oxygen to increase the temperature and to form carbon dioxide and hydrogen. Water is supplied to the annulus for cooling purposes and for injection into the gas and water mixing zone for cooling the gases therein and for forming steam whereby hydrogen, steam, and carbon dioxide are injected from the restricted outlet.

36763 Ion exchange controlled chemically aided waterflood process. Hill, H.J.; Reisberg, J.; Helfferich, F.G.; Lake, L.W.; Pope, G.A. (to Shell Oil Co.). US Patent 4,074,755. 21 Feb 1978. Filed date 21 Mar 1977. 14p.

A process is described for recovering oil by successively injecting at least a chemical slug containing an active aqueous surfactant system or thickened aqueous liquid and an aqueous drive liquid into a reservoir having a significant amount of ion exchange capacity. The ionic composition of each injected fluid is arranged to provide a ratio, between the concentration of its effectively predominate monovalent cation and the square root of the concentration of its effectively predominate divalent cation, which ratio at least substantially equals such a ratio within the aqueous fluid immediately ahead of the injected fluid.

36764 Extraction method and apparatus. Scott, H.W. (to Oil Recovery Corp.). US Patent 4,074,758. 21 Feb 1978. Filed date 3 Sep 1974. 6p.

A method and apparatus are provided for recovering oil from an oil bearing soil by means of an electrohydraulic shock wave generated in a liquid by capacitor electrical discharge means.

36765 Oil recovery process using a polymer slug with tapered surfactant concentration. Bousaid, I.S. (to Texaco Inc.). US Patent 4,074,759. 21 Feb 1978. Filed date 20 Sep 1976. 10p.

A process is described for recovering oil from a subterranean reservoir in which a slug comprising an aqueous polymer solution containing a small amount of surfactant injected into the formation via an injection well is forced through the formation and oil is recovered via a production well penetrating the formation. In this process the concentration of the surfactant in the slug of the aqueous polymer solution is tapered by increasing the concentration of the surfactant either incrementally, gradually or by any other convenient method during the slug injection time.

36766 Determination of residual oil in a subterranean formation. Casad, B.M. (to Continental Oil Co.). US Patent 4,071,756. 31 Jan 1978. Filed date 10 May 1976. 8p.

A method for obtaining logging data for use in the determination of the amount of residual oil in a subterranean oil bearing formation, the method comprising the steps of logging the formation, injecting into the formation an aqueous solution of a water soluble radioactive tracer compound, logging the formation, injecting into the formation a second aqueous solution of a radioactive tracer compound which is soluble in both water and oil, and thereafter logging the formation.

36767 Quarterly oil statistics. Fourth quarter 1977. *Q. Oil Stat.;* No. 1, 1-318(1978). (In English and French).

The aim of the publication is to provide rapid, accurate, and detailed statistics on oil supply and demand in the OECD area. The main components of the system are: complete balances of production, trade, refinery intake and output, final consumption, stock levels, and changes; separate data for crude oil, NGL, feedstocks, and nine product groups; separate trade data for main product groups, lpg, and naphtha; imports for 41 origins; exports for 29 destinations; marine bunkers and deliveries to international civil aviation by product group; aggregates of quarterly data to annual totals; and natural gas supply and consumption.

36768 Lockheed completes subsea manifold system for Brazil. *Ocean Ind.;* **12**: No. 7, 59-61(Jul 1977).

The unit will commingle crude oil flows from 9 satellite wells in the Garoupa field off Brazil, to the manifold center, where the crude oil will be metered before it enters one of the twin 12-in. production headers. (DLC)

36769 Hamilton Bros. expanding Argyll subsea system . *Ocean Ind.;* **12**: No. 7, 62-63(Jul 1977).

A fifth subsea tree is being added to the North Sea Argyll field to increase crude production from 48,000 to 60,000 bopd. The advantages of the subsea system over a fixed platform are pointed out. (DLC)

36770 Comex SEAL's Beryl field tree performs well in first year. *Ocean Ind.;* **12**: No. 7, 64-65(Jul 1977).

SEAL's Intermediate System (SIS), tree, which was used in North Sea's Beryl field, is based on the split-tree concept and on modular components. A simple wet tree unit is also described. (DLC)

36771 1977 tabulation of subsea completions. *Ocean Ind.;* **12**: No. 7, 68-84(Jul 1977).

During the past year, the offshore oil industry has installed 24 new seafloor production units and have ordered 10 more. The tabulation covers wet trees, experimental installations, hybrid completions, dry wellheads installed or to be installed, wet and dry trees assembled but not installed, and wet and dry trees on order. An offshore construction table is also included. (DLC)

36772 North Sea report. Swiss, M. *Oil Gas--Eur. Mag. (Engl. Transl.);* **3**: No. 2, 19-23(1977).

The British activities and international cooperation (with Norway) in the North Sea oil and gas field are described. The high incidenc of diving casualties is mentioned. The impact on British energy consumption is discussed; 98% of its gas comes from the North Sea. Production by each field and future plans and new ideas for development of new fields are discussed. The Norwegian North Sea is also covered. Developments off Eire are mentioned. (DLC)

36773 Use of the spinning drop interfacial tensiometer for evaluation of surfactants for low tension flooding: an experience report. Burkowsky, M.; Marx, C. (Univ., Clausthal, Ger.). *Oil Gas--Eur. Mag. (Engl. Transl.);* **3**: No. 2, 37-38(1977).

For the evaluation of surfactants for enhanced recovery processes the interfacial tension between crude oil and reservoir (or injection) water containing the surfactant under study, is widely used as a determining parameter. According to several authors, extremely low values of the interfacial tension ($\gamma < 10^{-3}$ dyn/cm) are necessary for mobilization of residual oil after water flooding. By using an interfacial tensiometer after Prof. Wade, U.S.A., a large number of measurements were taken in specific oilfield systems of North Germany, charracterized by high water salinity. Applying special operational procedures, the information obtained with the tensiometer could be greatly improved. With the interfacial tension γ as a function of surfactant concentration c/sub t/, temperature T, and time t, a quick-test method for the evaluation of surfactants was developed. Results are given for the reservoir system Vorhop-

Knesebeck and an anionic surfactant. Units of the available tensiometer and possibilities for its improvement are discussed.

36774 Quarterly oil statistics. First quarter 1977. *Q. Oil Stat.;* No. 2, 1-316(1977). (In English and French).

The publication is the second in a new quarterly series first published in April 1977. Its relationship to the quarterly oil statistics formerly published by the OECD was explained in "Quarterly Oil Statistics—3rd Quarter 1976" published in February 1977. The aim of the new publication is to provide rapid, accurate, and detailed statistics on oil supply and demand in the OECD area. The main components of the system are: complete balances of production, trade, refinery intake and output, final consumption, stock levels, and changes; separate data for crude oil, NGL, feedstocks, and nine product groups; separate trade data for main product groups, lpg, and naphtha; imports for 41 origins; exports for 29 destinations; marine bunkers and deliveries to international civil aviation by product groups; aggregates of quarterly data to annual totals; and natural gas supply and consumption.

36775 Quarterly oil statistics. Second quarter 1977. *Q. Oil Stat.;* No. 3, 1-309(1977). (In English and French).

The present publication is the second in a new quarterly series first published in April 1977. Its relationship to the quarterly oil statistics formerly published by the OECD was explained in "Quarterly Oil Statistics—3rd Quarter 1976" published in February 1977. The aim of the new publication is to provide rapid, accurate, and detailed statistics on oil supply and demand in the OECD area. The main components of the system are: complete balances of production, trade, refinery intake and output, final consumption, stock levels, and changes; separate data for crude oil, NGL, feedstocks, and nine product groups; separate trade data for main product groups, lpg, and naphtha; imports for 41 origins; exports for 29 destinations; marine bunkers and deliveries to international civil aviation by product group; aggregates of quarterly data to annual totals; and natural gas supply and consumption.

36776 Quarterly oil statistics. Third quarter 1977. *Q. Oil Stat.;* No. 4, 1-318(1977). (In English and French).

The present publication is the second in a new quarterly series first published in April 1977. Its relationship to the quarterly oil statistics formerly published by the OECD was explained in "Quarterly Oil Statistics—3rd Quarter 1976" published in February 1977. The aim of the new publication is to provide rapid, accurate and detailed statistics on oil supply and demand in the OECD area. The main components of the system are: complete balances of production, trade, refinery intake and output, final consumption, stock levels, and changes; separate data for crude oil, NGL, feedstocks, and nine product groups; separate trade data for main product groups, lpg, and naphtha; imports for 41 origins; exports for 29 destinations; marine bunkers and deliveries to international civil aviation by product group; aggregates of quarterly data to annual totals; and natural gas supply and consumption.

36777 Quarterly oil statistics. Fourth quarter 1976. *Q. Oil Stat.;* No. 1, 1-535(1977). (In English and French).

The present publication is the first in a new quarterly series. Its relationship to the quarterly oil statistics formerly published by the OECD was explained in "Quarterly Oil Statistics—3rd Quarter 1976" published in February 1977. The aim of the new publication is to provide rapid, accurate and detailed statistics on oil supply and demand in the OECD area. The main components of the system are: complete balances of production, trade, refinery intake and output, final consumption, stock levels, and changes; separate data for crude oil, NGL, feedstocks, and nine product groups; separate trade data for main product groups, lpg, and naphtha; imports for 41 origins; exports for 29 destinations; marine bunkers and deliveries to international civil aviation by product group; aggregates of quarterly data to annual totals; and natural gas supply and consumption.

PROCESSING

REFER ALSO TO CITATION(S) 36767, 36774, 36775, 36776, 36777, 36786, 37516

36778 Combined disulfurization and conversion with alkali metals. Bearden, R. Jr. (to Exxon Research and Engineering Co.). US Patent 4,076,613. 28 Feb 1978. Filed date 28 Apr 1975. 12p.

Improved processes are described for the combined desulfurization and hydroconversion of various sulfur-containing petroleum oils, and particularly various residua feedstocks. These feedstocks are contacted with alkali metals, such as sodium, in the molten state, in a conversion zone maintained at specified conditions such that the feedstocks are both desulfurized and subjected to significant hydroconversion, particularly demonstrated by significant reductions in the 1,050°F + fraction of these feedstocks, as well as significantly decreased Conradson carbon and increased API gravity. In addition, the deep demetallization and moderate denitrogenation of these feedstocks is also achieved. These important results are obtained by maintaining the conversion zone at temperatures of above 750°F, and in the presence of sufficient added hydrogen to produce a hydrogen pressure in the conversion zone of between about 1500 and 3000 psig.

36779 Catalyst regeneration by circulating catalyst in a hydrotreating oil process. Kanbier, D.; Goudriaan, F. (to Shell Oil Co.). US Patent 4,073,721. 14 Feb 1978. Priority date 6 Jul 1976, United Kingdom of Great Britain and Northern Ireland (UK). 6p.

A process is disclosed for catalytic hydrotreating of a heavy hydrocarbon oil and a light hydrocarbon oil in separate reactors, wherein the hydrotreating catalyst is circulated through both reactors. The process is particularly suited to obtaining long catalyst life when operating at low hydrogen pressures.

36780 Cracking power recovery from gas turbines. *Processing;* **24**: No. 2, 34-35(Feb 1978).

Energy can be recovered from waste gas streams in fluidized-bed catalytic cracking of oil in refineries. Construction and operation of a TH turbine are discussed. (DLC)

36781 Flare gas recovery system saves fuel. Lintonbon, R.F. *Processing;* **24**: No. 2, 64(Feb 1978).

The flaring of waste gases in petrochemical plants can be eliminated by a skid-mounted gas recovery unit. (DLC)

36782 Oil recovery process using viscosified surfactant. Meister, J.J. (to Phillips Petroleum Co.). US Patent 4,071,457. 31 Jan 1978. Filed date 30 Sep 1976. 12p.

Thixotropic compositions having initially relatively high viscosity which can decrease with time are prepared by mixing water and chloroform with an anionic surfactant, a cationic surfactant, an acid to adjust the pH of the aqueous phase to 4.5 or less, and a buffer salt. These compositions are valuable drilling fluids, fracturing fluids, and surfactant fluids for chemical flooding in tertiary oil recovery.

36783 Plugging high permeability zones of reservoirs having heterogeneous permeability. Sandiford, B.B. (to Union Oil Co. of California). US Patent 4,069,869. 24 Jan 1978. Filed date 11 Feb 1977. 14p.

A method of forming a mixed plug in the more permeable zones of a subterranean reservoir of nonuniform permeability in which there is injected into the reservoir aqueous solutions of: a polymer, a material that reacts with the polymer to form a time-delayed polymer-containing plug, an alkali metal silicate and a material that reacts with the silicate to form a time-delayed silicate-containing plugs. The injected solutions are either mixed at the surface prior to injection or are simultaneously injected so that a mixed polymer-silicate plug is formed in the reservoir.

36784 Use crude to produce on-the-spot fuel. *Ocean Ind.;* **12**: No. 7, 91(Jul 1977).

A Distillate Fuel System has been introduced by Riley Beaird, Inc. which produces diesel fuel directly from crude oil in remote areas. Production capacity is 300-400 bpd of distillate fuel. (DLC)

PRODUCTS AND BY-PRODUCTS

REFER ALSO TO CITATION(S) 36767, 36774, 36775, 36776, 36777, 36844

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 36767, 36774, 36775, 36776, 36777

36785 International oil revisited: could the experts be wrong. New York; Irving Trust Co. (1977). 8p.

It is shown that there is no reason to expect a major oil shortage between now and 1985, given present supply and demand trends. Oil surpluses will continue at least through 1982. A recession is expected in 1981 which will affect oil consumption. Oil supplies, both OPEC and non-OPEC, are discussed. U. S. policy options are considered. A reprint of "Oil and the International Economy" in Business Economics is included. (DLC)

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 36828

36786 Process for reducing flue gas contaminants from fluid cracking catalyst regenerator. Luckenbach, E.C. (to Exxon Research and Engineering Co.). US Patent 4,081,508. 28 Mar 1978. Filed date 4 Jun 1975. 8p.

Noxious emissions produced in the process of regenerating catalysts employed in the catalytic cracking of hydrocarbons are reduced by burning the coke on the spent catalyst in a regenerator operated at a temperature greater than 1200°F to produce flue gas containing less than 2.0 vol. % carbon monoxide, expanding the flue gas from the regenerator through a turbine to reduce the pressure of the flue gas, recovering and utilizing energy produced from the expansion, introducing the expanded gas into a venturi structure, contacting the expanded gas with a low pressure stream of an aqueous scrubbing mixture, passing the flue gas and the scrubbing mixture through a constricted passage of the venturi structure to increase the turbulence and velocity of the liquid and gaseous streams thereby producing intimate contact thereof, discharging the mixture of gas and scrubbing liquid into a separation zone, and separating the mixture of gas and scrubbing liquid into a liquid portion and a gaseous portion having a reduced content of solid catalytic particulates and acidic gases.

36787 Removing free oil from waste streams. Toms, A.W. *Processing;* **24**: No. 2, 58-59(Feb 1978).

A new separator is now offered by Hyde Products, Inc. of Cleveland, Ohio, which offers more powerful separations than other gravity units. The system uses gravity flow of feed water through a bed of lightweight porous media; it is based on D'Arcy's equation. A plant to be installed at Kuwait Oil Co., can handle an effluent containing 300 to 1000 ppM oil to give an effluent with less than 10 ppM. Other applications are in oil removal from coolants, washers, quench systems, oil production waters, refinery waste waters, etc. (DLC)

36788 Navy development of suitable shipboard bilge oil/water separators. Smookler, A.L.; Harden, J.W. Jr.; Conroy, P.D. (Taylor Naval Ship Research and Development Center, Annapolis). pp 423-428 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

The evolutionary development and evaluation of a suitable Navy shipboard bilge oil/water separator is detailed. Evaluations were performed at four levels: laboratory screening tests, shipboard screening tests, formal shipboard technical evaluations (TECHEVALS) and operational evaluations (OPEVALS). Gravitational and filter/coalescer systems, as well as systems combining these techniques were evaluated. Initial shipboard screening tests revealed significant problems caused by particulates and detergents in the bilge fluids. Although effluent goals could be met, severe penalties in terms of costs to process, logistics support, and size of separation equipment were evident. Screening tests produced three promising systems for formal TECHEVALS: a parallel-plate gravity separator, and two designs for gravity/filter/coalescer systems. TECHEVAL included in-port and at-sea performance tests, bulk oil removal, oily waste holding tank and detergent-contaminated waste processing demonstrations, and reliability and maintainability assessments. Performance goals were established for effluent oil levels during in-port and at-sea periods, water content of separated oil, average element set life, cost to process, mechanical/electrical reliability, and mean time to repair. As a result of TECHEVAL, the parallel-plate separator was selected for OPEVAL and modified to improve its structural adequacy and machinery/personnel interface. The OPEVAL was structured to determine if the unit could be operated and maintained by ship's personnel, while processing both actual and deliberately contaminated bilge water on a daily basis for six months.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 36787, 36836, 36837, 36838, 36839, 36847, 36848, 36856, 37990, 38026, 38027, 38058, 38067, 38072, 38073, 38074, 38075, 38076, 38077, 38078, 38079, 38080, 38081, 38082, 38083, 38084, 38085, 38086, 38087, 38088, 38089, 38090, 38091, 38092, 38093, 38096, 38097, 38098, 38099, 38100, 38101, 38102, 38103, 38104, 38105, 38106, 38107, 38108, 38110, 38111, 38112, 38113, 38114, 38115, 38116, 38117, 38118, 38119, 38120, 38121, 38122, 38123, 38127, 38128, 38129, 38130, 38131, 38132, 38253, 38254, 38255, 38256, 38258, 38273, 38274, 38275, 38276, 38277, 38278, 38279, 38280, 38295

36789 Radar detection of the oil contaminations of the sea surface. Galaev, Yu.M.; Kalmykov, A.I.; Kurekin, A.S.; Lementa, Yu.A.; Nelepo, B.A.; Ostrovskii, I.E.; Pichugin, A.P.; Pustovoitenko, V.V.; Terekhin, Yu.V. (Inst. of Radio Physics and Electronics, Moscow). *Izv. Akad. Nauk SSSR, Fiz. Atmos. Okeana;* **13**: No. 4, 406-414(Apr 1977). (In Russian).

The results are discussed of the experimental investigation of the characteristics of the radiowave scattering from the sea surface contaminated by the oil products. The investigation has been performed at the moderate sea with radiowaves lambda = 3.3 and 10 cm and high coordinate resolution as well. The presence of the layer of the oil products leads to the reduction of the scattered signal in the point of the spot detection reaching more than 20 db with lambda = 3.2 cm and more than 18 db with lambda = 10 cm. Within the resonance scatter mechanism the effect is considered of the oil product layer on the characteristics of the radar signals scattered from the sea surface in different observation points. Requirements for parameters of the measuring apparatus detecting oil contaminations on the sea surface are discussed.

36790 Hydrodynamics of a diversionary boom. McCracken, W.W. (Mason and Hanger-Silas Mason Co., Inc., Leonardo, NJ); Freestone, F.J. pp 329-334 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

The failure of booms to contain oil in currents above 0.5 meters per second (mps) when deployed in a containment mode appears to be well established. A method suggested to surmount this limitation is to use the boom in a diversionary mode with the intent to move the oil into regions of low currents where containment and removal can be accomplished. Previous tests with booms deployed in a diversionary mode have shown that oil droplets are entrained in a flow under the booms at lower current than theory predicted. Failure of a boom to control oil was shown to occur over approximately one-third of the length of the boom, near the trailing end. The U.S. Environmental Protection Agency sponsored a test program at their Oil and Hazardous Materials Simulated Environmental Test Tank (OHMSETT) to study the near-field hydrodynamics of a diversionary boom. Three dimensional flow fields were first examined visually using dye and oil droplets with an under-water video system designed and built as part of the program. Turbulence intensity was measured with a single-axis, hot-film anemometry probe.

36791 Use of floating deflectors for oil spill control in fast flowing waters. Eryuzlu, N.E. (Canadian Coast Guard, Ottawa); Hausser, R. pp 335-340 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

Although oil booms of various types now are available, it is well established that they are ineffective when the spill occurs in fast flowing waters. A system was developed to control an oil spill under such circumstances. The principle employed is to deflect the oil from where the spill takes place into a portion of the river where the currents are slower and the oil could be collected by conventional means. This is achieved by a system of floating deflectors comprising a series of hydrofoils mounted on a horizontal frame anchored to the shore. The interaction of the hydrodynamic forces on the hydrofoils creates an equilibrium state at which the system floats at an angle with the main current. At this equilibrium state the deflectors induce a controlled spiral circulation which deflects the surface currents and spilled oil in a selected direction. Experiments were conducted in a straight flume to study the characteristics of hydrofoils used as deflectors. The general location of the several oil refineries around Montreal-East was selected for testing the practical application of the proposed method on a model of the St. Lawrence River. Results show that in the majority of cases without deflectors only about 40 to 50 percent of the oil would go in the north arm of the river, whereas with the deflectors this can increase to about 90 percent. Presently, preparations are being made for a prototype testing program to be conducted near Montreal-East on the St. Lawrence River.

36792 Performance tests of three fast current oil recovery devices. Getman, J.H. (Office of Research and Development, Washington, DC). pp 341-346 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

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Presently, the effective removal of oil spills is limited to current speeds of less than one to two knots. To be able to effectively recover spilled oil in areas of higher current speeds, the Coast

Guard has a development effort underway for obtaining such a device. The first stage of the development program included a competitive evaluation of small scale models of seven different fast current oil recovery concepts. The two most promising concepts have now been developed into large scale models. These two devices plus a third device which evolved from a parallel state-of-the-art evaluation program were tested during the summer of 1976 at the Environmental Protection Agency's Oil and Hazardous Materials Simulated Environmental Test Tank (OHMSETT). The Shell ZRV large scale model performed well in fast-current velocities in both calm seas and in a wave train. The Seaward Steaming Fiber Recovery Device performed well in fast currents in calm conditions but performed poorly in waves. The French Cyclonet 050 provided fair performance in medium currents and in calm conditions but gave poor performance when waves were present.

36793 Surface enhancement: bringing it all together. Wilson, J.E. (Naval Facilities Engineering Command, Alexandria, VA). pp 347-354 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

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Pursuit of a concept as simple as reversing the oil spill spreading phenomenon has resulted in the development of a very effective methodology for cleaning up U.S. Navy oil spills. New equipment and techniques are now routinely used throughout the Navy where spills occur. Two comprehensive spill cleanup scenarios which extensively utilize the surface enhancement equipment and techniques are described. The two scenarios are: confined area spill, with the skimmer in a stationary mode; and open area spill, with the skimmer in a moving mode. The confined area stationary mode scenario employs boat propeller wash, air and water jets remote to the skimmer, surface active agents, granular or chip sorbents, and water and air jets built into the skimmer/boom system. Data is presented which shows that skimmer performance can be improved by factors of 8 and 18 for water and air enhancement systems respectively. The open area moving mode scenario employs a skimmer with boom and two utility boats in a "V" configuration with granular sorbents, piston film, etc., or a skimmer with oil concentration sweeps having built-in water jets and with granular sorbents, piston films, etc. Examples are presented which clearly show that low speed skimming (under 2.5 knots) while utilizing surface enhancement techniques is more cost effective than high speed skimming, even if 80 percent throughout efficiencies could be achieved.

36794 French oil spill policy: the recovery phase. Guerin, P. (Secretariat General de la Marine Marchande, Paris); Pichon, J. pp 355-360 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

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Mechanical recovery and chemical distersion are the two basic techniques available to countries concerned with the oil spill problem. France has placed its emphasis on recovery, and uses dispersion for occasional polishing only. The containment, recovery and storage equipment is based at strategic points along the coast to permit effective intervention at short notice. Details are provided concerning this recovery equipment, which includes floating booms, skimmers (dynamic and static), and towable, floating, flexible storage containers.

36795 SOCK: an oil skimming kit for vessels of convenience. Ayers, R.R. (Shell Development Co., Houston, TX); Barnett, A.V. pp 361-366 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

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An oil spill skimmer kit is under development for emergency use in the Gulf of Alaska. The Spilled Oil Containment Kit (SOCK) is containerized oil containment and removal equipment to be deployed on either side of a vessel of convenience, making the vessel an emergency sweep skimmer. Frame-supported nylon/nitrile rubber socks are tied alongside the vessel to provide a sweep width of 50 ft plus the vessel beam. Pump and storage are also included. The sock is unlike containment booms used previously in that both wave damper and oil recovery means are integral parts of the design. Based on model tests, the skimmer performance is expected to approach that of state-of-the-art skimmers. The major advantage of this kit will be a low capital outlay since no vessel must be built. Outfitting 10 vessels of convenience will perhaps equal the capital outlay for one special purpose skimming vessel, so that SOCK should provide a cost-effective means of supplementing dedicated skimmers used in an offshore spill.

36796 Development of oil spill recovery ship. Uchida, S. (Nagasaki Shipyard and Engine Works, Japan); Takeshita, H.; Seike, Y. pp 367-374 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

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A compact oil spill recovery system made up of a special oil suction float, an educator-driven hydraulic fluid conveying unit, an oil/water separating unit, etc., was devised to the basic design concept of the previously-developed Mitsubishi hydraulic tanker desludging system and installed in a small, self-propelled, twin-hull craft. A 9.60 m long, 4.10 m wide, and 1.40 m deep experimental oil spill recovery ship completed in this manner successfully cleaned up a slick of heavy oil, 7 m x 30 m in area and 0.7 to 2.0 mm in film thickness, in less than three minutes at 0.5 to 1.0 kt and proved very stable, steerable, and easy to operate. Oil content of water at the outlet of the oil/water separating unit was less than 1 ppM. A range of oil spill recovery ships have since been designed, fully weighing opinions of potential customers as regards such items as economy of operation, and capacity.

36797 Combined skimmer-barrier high seas oil recovery system. Milgram, J.H. (Massachusetts Inst. of Tech., Cambridge); Griffiths, R.A. pp 375-379 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

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This paper describes the development of an oil recovery system to be used in conjunction with the U.S. Coast Guard's high seas oil containment barriers. The system was tested at the EPA's OHMSETT facility in 1975. Its oil recovery capability was shown to be good, with promise for yet better recovery when used on a large spill. Operational practicality was demonstrated in sea trials during May 1976, when the barrier was string towed, catenary towed, and moored in a tidal current. Because of the difficulty of handling large or complicated equipment in offshore conditions, a major design criterion was that the system be as simple as possible. Weir skimmers are particularly simple, but collection of more oil than water or air requires that the weirs follow the vertical motion of the waves. Simplicity and efficiency were achieved by utilizing the wave-following ability of the Coast Guard barrier design. Weirs were built into six struts at the center of a length of barrier, so that barrier deployment results in simultaneous skimmer deployment. To recover oil, it is only necessary to attach pump hoses to the barrier. Three double-acting diaphragm pumps are used. These self-priming pumps were specifically designed to pass any debris that can enter through the three-inch diameter suction hoses. Hydraulic drive was chosen so the pumps could be powered by the Coast Guard's ADAPTS diesel-engine-driven hydraulic power units.

36798 Some recent observations regarding the unique characteristics and effectiveness of self-mix chemical dispersants. Canevari, G.P. (Exxon Research and Engineering Co., Florham Park, NJ). pp 387-390 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

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There has been an increasing awareness of the utility of conventional chemical dispersants in general, and self-mix dispersants in particular as a viable means to minimize damage from oil spills. This paper will update the use of, and activity regarding, the self-mix dispersant as noted in applications over the past two years. In addition, those aspects that are still little understood are discussed. Specifically, uniformly sized, dispersed oil droplets of approximately 1 micron diameter are formed by the diffusion action of self-mix chemical dispersants. The droplet size influences the dilution rate of the spilled oil in field applications, and data to support this are presented. The results of laboratory bioassays performed with these much smaller dispersed oil droplets, as opposed to larger droplets formed with mechanical mixing, can be misinterpreted since the increased rate of dilution afforded by smaller droplet size is not replicated. In addition to the vital dilution study results, this paper also presents evidence to clarify several popular misconceptions regarding chemical dispersants. For example, it is explained that the apparent synergistic effects between oil and dispersant do not indicate that chemical dispersants release toxic substances from the oil into the water. Data is also presented which shows that dispersants do not cause the oil to sink.

36799 Considerations for field use of dispersants. McCarthy, L.T. Jr. (Environmental Protection Agency, Edison, NJ). pp 399-401 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

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A rationale is presented for the correlation of laboratory generated dispersant data to the spill situation in the field. Discussion and tabular presentation of data supports the rationale, which incorporates application factors for dispersant toxicity and effectiveness data to initial concentrations of oil and dispersants in the water column after dispersant application in the field. The EPA's current research projects on oil spill dispersants are summarized.

36800 Techniques for mixing dispersant-treated oil slicks into the water. Smith, G.F.; McCracken, W.E. (Mason and Hanger-Silas Mason Co., Inc., Leonardo, NJ). pp 403-406 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

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The effective use of dispersants requires the addition of mixing energy to the oil slick after the application of the dispersant chemicals. This U.S. Environmental Protection Agency sponsored project was conducted at their OHMSETT testing facility to test the relative effectiveness of four devices for adding mixing energy to an oil slick under varied conditions. The four devices were: a five-bar gate, two fire-hose streams, a modified five-bar gate, and a small outboard motorboat. Tow speeds, wave conditions, and oil/water interfacial tension were varied. Underwater photography was used to record the depth of penetration of the oil droplets caused by the mixing devices at each test condition.

36801 New concept of oil dispersion in view of clean up by degradation. Bocard, C. (Institut Francais du Petrole, Rueil-Malmaison); Durif-Varambon, B.; Gatellier, C.; Renault, P.; Laboureur, P.; Person, L. pp 407-410 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

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Some misunderstanding has arisen from evidence of deleterious effects of oil dispersion, leading to the conclusion that such a treatment is more dangerous than the pollution itself. In fact, the main objective is to promote the speed of degradation by parcelling of oil, the droplets becoming widespread and bursting at the ocean surface to form films which quickly will disintegrate under microbial actions. With new dispersant formulations, the hydrocarbon pollutants will tend to separate out from sea water so that living organisms would not be injured in the comparatively clean water below. Meanwhile, by its chemical composition, the dispersant will bring nutrients to the medium and, moreover, will remain within the oil phase.

36802 Fast surface delivery system for pollution response equipment. Larrabee, R.M. (Coast Guard Headquarters, Washington, DC); Ward, R. pp 417-421 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

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The U.S. Coast Guard has undertaken the development of a Fast Service Delivery System in order to provide an efficient means to deliver pollution response equipment to the scene of a high seas oil spill. A planing hull sled, towable by surface vessel or helicopter, was designed by the U.S. Naval Coastal Systems Laboratory as the transportation vehicle. The all-aluminum sled has a 15-foot beam and is 45 feet long and weighs 10,000 pounds. The system can deliver a 20,000-pound payload and can be unloaded at sea manually. Test results have shown that the equipment-loaded sled can be safely and efficiently towed by an HH3F helicopter at speeds up to 50 knots and by a Coast Guard 82-foot WPB at speeds up to 17 knots in sea state 3 or less. The empty sled, at rest in the water, lies with the aft end submerged. Sled-mounted hand winches are used to inhaul and secure the floating payload. After the sled is underway, the water drains, the stern comes up, and the sled hydroplanes. At the deployment site, quick-release hooks on the lines securing the equipment to the sled are tripped and the stern submerges, leaving the payload floating free.

36803 New test facilities for the prevention of oil pollution in Japan. Yazaki, A. (Shipbuilding Research Centre of Japan, Tokyo). pp 429-433 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

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New test facilities under construction in Japan for conducting research on developing and evaluating oil-fences and oil-recovery equipment include a circulating water channel, a rectangular tank, and an oil/water purifier system. The circulating water channel is 60 m in length, 3.8 m in width, and 5.1 m in depth. It is provided with a water circulating system which gives a water speed of up to 2 knots, a wave generator which generates waves of up to 0.6 m in height, an air blower which gives wind speed of up to 20 m/s, and a surface current generator which generates surface speeds of up to 1 knot. It is also equipped with a dispersing and recovering system for the test oil. The rectangular tank, 80 m in length, 45 m in width, and 2.6 m in depth, is provided with a wave generator which generates waves of up to 0.3 m in height and a towing carriage which runs at a speed of up to 2 m/s. Covered by a roof which allows testing all the year round independent of weather or temperature, these new facilities are expected to be completed by the end of 1977 and opened for use at the beginning of 1978.

36804 Persistence of non-alkane components of Bunker C oil in beach sediments of Chedabucto Bay, and lack of their metabolism by molluscs. Vandermeulen, J.H. (Bedford Inst. of Oceanography, Dartmouth, Nova Scotia); Keizer, P.D.; Penrose, W.R. pp 469-473 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

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Analysis of cores from a continuously oiled beach shows that seven-year-old stranded Bunker C fuel oil re-entering the beach substrate is rapidly degraded. This weathering occurs throughout the top 15 cms of the beach sediments. The aromatic and cycloalkane components, however, appear resistant and unaltered. Thus the beach sediments act as effective n-alkane filters, but simultaneously become enriched with aromatic hydrocarbons. Bivalves from these oiled sediments, and from other non-oiled areas, were assayed for their ability to degrade aromatic hydrocarbons, and for their ability to respond to oil exposure by induced elevated levels of aryl hydrocarbon hydroxylase (AHH). Both non-oiled Mya arenaria, Mytilus edulis, and Ostrea endulis exposed to aquenous extracts of Kuwait crude and a Bunker C fuel oil, and M. arenaria and M. edulis from Arrow Bunker C oiled sediments lacked the AHH system, as shown by their inability to hydroxylate benzo(a)pyrene or demethylate ^{14}C-imipramine. Discussion is centered on the implications of this metabolic inability to degrade aromatic hydrocarbons in bivalves residing in aromatic enriched sediments.

36805 Priorities in fate of oil spill research. Kolpack, R.L. (Univ. of Southern California, Los Angeles). pp 483-485 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

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A three-dimensional computer simulation model, based on rate data obtained from the literature, was used to evaluate the interaction of different types of petroleum hydrocarbons for a range of environmental conditions in the marine environment. Research efforts that will be required to gain a better understanding of the fate of oil in the ocean were categorized with respect to five major environmental reservoirs. Priority assessments were oriented toward critical areas where the present data are either not available or are inadequate. Processes operating at the water surface are considered to be the most important, and processes operative in the atmospheric reservoir are the least important. High priority research topics include: spreading, mixing, dissolution, emulsification, photochemical degradation, bottom transport and degradation, sorption of oil on particulates and coordinated studies of processes active in the nearshore zone.

36806 Review of some commonly used parameters for the determination of oil pollution. Gruenfeld, M.; Frank, U. (Industrial Environmental Research Lab., Cincinnati). pp 487-491 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

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A state-of-the-art review is provided describing specific parameters of petroleum oils that are used by various investigators to demonstrate the presence of oil pollution in water, sediments, and biological tissues. Several representative publications are discussed with regard to the techniques used for distinguishing between petroleum hydrocarbons and organics that are of recent biological origin. The techniques include chromatographic procedures using alumina and silica gel for separating hydrocarbons from other organics, followed by instrumental methods such as gas chromatography, fluorescence spectroscopy, ultraviolet absorption spectroscopy, et al. The various oil parameters that are used to demonstrate the presence of petroleum oils are discussed, and the most effective ones are recommended. In addition, a recent study is also described in which several of the parameters were used to demonstrate the presence of oil pollution in sediments from a mangrove swamp in Puerto Rico.

36807 SPCC planning: good management practice. Clark, D.A. (Clark Associates, Norfolk, VA). pp 55-56 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

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The Oil Spill Prevention Program of the Environmental Protection Agency (EPA) requires Spill Prevention Control and Countermeasure (SPCC) plans for facilities with oil storage capacity above certain minimum amounts. The object of this paper is to discuss the additional beneficial effects of a good SPCC plan beyond the obvious reduction in spill hazard. A good spill prevention plan includes many fundamental good management practices. Cleaner, more attractive facilities, accurate inventories, and safer working conditions, are some of the improvements that may go along as part of a good spill prevention program. Specific examples are drawn from experiences in SPCC planning for a variety of facilities such as home heating oil distributors, truck stop operations, and large manufacturing facilities. Facilities required to have an SPCC plan have more to gain than mere compliance with federal regulations when they put their plan into effect. With a good spill prevention plan, the facility will operate more effectively and more profitably.

36808 Preventing oil spills in the west coast forest industry. Melville, L.; Hamm, P. (MacMillan Bloedel Ltd., Vancouver, British Columbia). pp 57-59 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

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MacMillan Bloedel, Canada's largest forest products company, uses about 67 million gallons of oil products annually. Moving, storing and dispensing such quantities calls for effective measures against spills, leaks and the problem of waste oil disposal. Experience has shown that prevention of oil losses must begin with a properly developed set of control standards endorsed by senior management and accepted by line personnel. A necessary adjunct is a major education and training program. The company's enlightened approach to spill prevention and cleanup has resulted in a significant reduction in the number and magnitude of oil spills at MacMillan Bloedel operations. A side benefit has been reduced oil consumption for lubricating and heating purposes at some of the company operations.

36809 Story of a successful oil spill cooperative: the Corpus Christi Area Oil Spill Control Association. Franklin, H.L. (Corpus Christi Area Oil Spill Control Association, TX). pp 65-68 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

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The Corpus Christi Area Oil Spill Control Association, founded in 1970 as a nonprofit Texas corporation to provide the Coastal Bend area of South Texas with a reasonable capability to contain and harvest oil spills on the area's shallow waters, can be considered a successful cooperative for two primary reasons. The first is the smooth blending of industry with federal, state, and local governments to create a working entity. The association, originally funded by each of these partners, is governed by a five-man board with a representative from each. Its operating budget is shared by government and industry alike on a 50-50 basis. The second reason is the low average cleanup cost, 40 cents per gallon. To date the association has cleaned up 167 assorted spills with the first occurring in November 1971. The largest spill amounted to 8,000 barrels, covering approximately 10 miles of ship channel area; the smallest spill was less than one barrel. The association has been commended by the Environmental Protection Agency, the U.S. Coast Guard, the State of Texas, and industry groups. It is the recipient of the Gold Medal Award from the National Sports Foundation and has been assigned the use of EPA's unique beach sand cleaner.

36810 Oil spill contingency planning for the BP Forties oilfield production, pipeline, and terminal systems. Fulleylove, R.J.; Lester, T.E. (British Petroleum Co., Ltd., Sunbury-on-Thames, Eng.). pp 87-90 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

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The Forties oil field in the UK sector of the North Sea is about 100 miles off the Scottish coast. Four steel platforms will eventually produce 500,000 barrels of oil per day, and deliver it by the subsea pipeline and 130-mile landline to the BP Grangemouth oil refinery and the Hound Point oil terminal on the Firth of Forth. Although the safety measures both on the platforms at sea and on the shore installation should largely negate the risk of oil spillage, BP has developed oil spill contingency plans to cover the entire Forties system, from the production platforms to the refinery and tanker terminal. This paper describes these plans and the types of problems involved. The work has required, in part, re-examining methods of oil spill cleanup at sea and on land, bearing in mind ecological problems, and redesigning equipment where necessary; coordinating with relevant authorities, and insuring personnel involved in the plans are adequately trained.

36811 Oil spill control in Alberta. Bohme, V.E.; Brushett, E.R. (Energy Resources Conservation Board, Calgary, Canada). pp 91-94 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

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Alberta is a major oil-producing region in North America. In excess of one-half billion barrels per year are produced from 10,000 oil wells. Oil and produced salt water are transported through 20,000 miles of pipelines. More than 600 oil and salt water spills per year occur, generally on land. The Energy Resources Conservation Board is responsible for the administration of the oil and gas industry. The board's policies and regulations relating to spill prevention, oil spill contingency planning, containment and cleanup are broad and flexible to permit industry a relatively high degree of freedom to operate in this area of rapidly-changing technology. While each company is held responsible for containment and cleanup of its own spills, the board supports the oil spill cooperative concept in spill equipment maintenance, contingency plan preparation and spill response training. Careful containment and cleanup of oil and salt spills will minimize soil and vegetation damage. This, followed by comprehensive evaluation of spill effects, enables implementation of more effective rehabilitation programs.

36812 Tanker/pipeline controversy. Stewart, R.J. (Martingale Inc., Cambridge, MA). pp 95-99 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

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The problems of drawing comparisons between alternative tanker and pipeline transportation systems are discussed. The statistical properties of mean values calculated for samples drawn from highly skewed populations are outlined. Existing U.S. spill data resources are critiqued. A sample regression result of number of spills versus port calls is presented.

36813 Technical support of spill control operations. Marum, J.P. (Standard Oil Co. (Indiana), Chicago); Quanstrom, W.R.; Will, R.G. pp 101-103 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

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Standard Oil Company (Indiana) has established a corporate technical support group to strengthen its response to oil spills and their after-effects. The primary function of this group is to advise and provide consultation to line management of the Amoco companies in dealing with the environmental problems resulting from a spill. Specialists in the group include personnel skilled in control and cleanup techniques, a terrestrial ecologist, a marine biologist, an aquifer specialist, a soils engineer, an experienced water chemist and several others. One or more members of the group proceed to the scene of a spill upon request as provided for in the contingency plans of the various Amoco subsidiaries. On arriving at the scene, the

technical support group surveys the spill situation, makes an environmental damage appraisal, evaluates the spill control measures underway, and then makes recommendations on spill control priorities and techniques. Members of the group also document the immediate and subsequent environmental effects of the spill. Line management has found it especially valuable to have their own experts at the scene to meet with various governmental and private experts. Two case histories describing the involvement of the corporate technical support group in control of gasoline spills are presented.

36814 Development and use of resource sensitivity maps for oil spill countermeasures. Hum, S. (Environment Canada, West Vancouver, B.C.). pp 105-110 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

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In an environmental emergency, immediate resource location and sensitivity information is necessary to provide for optimal protection and for establishing priorities for the deployment of protective equipment and forces. To efficiently expedite resource protection and alerting procedures, land-foreshore status and access points must be available immediately to the decision makers. Regular channels of communications are not dependable enough to ensure the availability of this information to them. This paper discusses the development and use of resource sensitivity maps. The maps contain sufficient details of biological resources, current land and water uses, present access and land status, tide-current data and wind patterns to enhance initial decision-making until more detailed information systems are available and on line. The maps cover certain coastal areas of the Province of British Columbia (Canada) and were developed by the Environmental Protection Service (Pacific Region) of Environment Canada with much cooperation from numerous other agencies.

36815 Oil spill response planning for biologically sensitive areas. Lindstedt-Siva, J. (Atlantic Richfield Co., Los Angeles). pp 111-114 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

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Oil spill response plans should be tailored to fit the environment in which they will be used. This involves examining physical processes so that the fate of spilled oil may be predicted, and identifying sites that are particularly vulnerable to oil spill damage, i.e., biologically sensitive areas. If these things are known about a region, spill response plans can be designed to prevent oil from entering these sensitive areas. As a consequence, environmental damage can be minimized when biological protection, as well as physical cleanup, is made a primary goal in any spill response plan. Clean Seas, Inc., an oil spill cooperative in Santa Barbara is implementing such a spill response plan designed to protect identified biologically sensitive areas in the Santa Barbara Channel. Protection systems are adapted to fit each site, and the plan is practiced through regular drills. This type of planning decreases the number of decisions that must be made after a spill occurs, thereby reducing both the reaction time and environmental damage.

36816 Bad day at Bunker Point. Marcus, E. (Gulf Trading and Transportation Co., Philadelphia). pp 139-140 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

The first phase of a four-part program by Gulf Trading and Transportation Company (GT and T) to improve existing oil spill policies and procedures was completed recently. This phase, known as the "Bad Day at Bunker Point" seminars, utilizes multimedia, role-playing exercises designed to sensitize key ship personnel and terminal managers to the problems and responsibilities of doing business in today's world. Other phases in the GT and T program include visits by the safety and environmental inspection team to all of the company's 60 major terminals to evaluate operational procedures and equipment and to recommend needed changes and updating. Later, the inspection team will make periodic, but unscheduled, spot-checks of these terminals to make sure previous recommendations have been carried out and to insure that contingency plans are changed as technology improves. The final element of the program is establishment of a "fast-response team" made up of representatives of marine operations, engineering, public relations, environmental, legal, insurance and personnel departments to assist terminal personnel in the event of a major oil spill.

36817 Hiatusport: an on-scene coordinator role-playing excercise. Kangeter, E.B. III. (Reserve Training Center, Yorktown, VA). pp 141-143 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

"Hiatusport" is an exercise utilized by the U.S. Coast Guard as the culmination of training for on-scene coordinators (OSC) and staff. Emphasis is placed on management of information and resources to achieve response goals established for the federal government by the National Oil and Hazardous Substances Pollution Contingency Plan. In addition to the primary task of spill cleanup, significant public relations problems involving the press, political figures, and private citizens interject the pressure-cooker atmosphere of the on-scene command post during a major spill. For the problem, students are divided into groups and assume roles such as OSC and public relations coordinator. After a briefing on the opening situation, the first group occupies the "Command post" and begins playing the exercise. Each of the four one-hour segments has specific objectives (e.g., evaluate spiller's action to determine if a federal response is appropriate). At the conclusion of each segment, a critique is conducted using a predetermined list of discussion points. The "Hiatusport" technique provides definite insights adaptable for use in other training programs.

36818 Development of an oil-in-water content monitor. Hornig, A.W. (Baird-Atomic, Inc., Bedford, MA); Brownrigg, J.T.; Chisholm, B.R.; Giering, L.P.; Skewes, R.L. pp 147-152 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

For several years Baird-Atomic has been involved in the design, construction and testing of a breadboard oil-in-water content monitor for use with bilge and ballast wastewater. This work has been supported by the Coast Guard, the Navy, and Baird-Atomic. The basis of the monitor is the luminescence (fluorescence) of the aromatics present in all petroleum oils. The advantages of this approach include high sensitivity, real time output, fast response time, insensitivity to many interferences, and reduced sensitivity to particulates. The chief problem is the unequal luminescence response of oils. The general approach involves simultaneous excitation and monitoring at a number of wave lengths, selected to give a net response almost independent of oil type. A first approach involved a novel optical scheme involving two polychromators. The first provided excitation at different wave-lengths along a flowing sample. The second, operated in reverse, summed selected emission from different portions of the sample. This approach, called "synchronous scan," while successful, was supplanted by a more general approach which utilized the total luminescence of the sample: i.e., all possible emissions resulting from all possible excitation. In this case, the second polychromator was used to disperse emission from the sample at right angles to the excitation dispersion. The total luminescence was then imaged at the exit plane of the second monochromator where a computer-designed mask selected those spectral regions equalizing response of various oil types. Results of tests are discussed, together with progress on a shipboard prototype.

36819 Aerial photographic applications in support of oil spill cleanup, control, and prevention. Jones, D. (Environmental Protection Agency, Washington, DC); Landers, R.; Pressman, A. pp 221-222 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

For several years the Environmental Protection Agency and EPA contractor aircraft have carried out aerial photographic missions, mapping the areal extent of and shoreline contamination from major oil spills in support of cleanup and control operations and environmental damage assessment. In 1975, EPA began a program of aerial photographic overflights of selected onshore oil production, storage and processing facilities to support the compliance monitoring of EPA's oil pollution prevention regulation. This paper describes the aerial mapping program and also discusses specific applications of aerial photography to oil pollution prevention compliance monitoring.

36820 Prevention of pollution during oil transfer operations: an evaluation of USCG preventive actions. Harrald, J.R. (Coast Guard, Washington, DC); Karwan, K.R.; Stone, C.M. pp 223-227 of Proceedings of the 1977 oil spill conference (prevention, behavior,

control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

Durings its journey from a production facility to a refinery, the most probable time for oil to enter the water is during vessel cargo-transfer operations. This paper describes the origins, implementation, and effects of the U.S. Coast Guard's operational and regulatory program designed to prevent oil transfer-related discharges. Statistical data from the USCG Pollution Incident Reporting System (PIRS) is used to measure the effectiveness of these actions. A review is presented of the results of an on-scene transfer monitoring program conducted in 1972 in Seattle, Washington. Coast Guard pollution prevention regulations (33 CFR 154-156) were designated to prevent the occurrence of discharges during transfer operations. An analysis of the effectiveness of these regulations and the present nationwide transfer operations monitoring program is presented. The paper concludes that the Coast Guard preventive program has had a measurable effect on the incidence of transfer-related pollution incidents.

36821 Evaluation of selected surface treatment agents for the protection of shorelines from oil spills. Foget, C.R. (Woodward-Clyde Consultants, San Francisco); Thornton, S.; Castle, R. pp 237-241 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

Recent laboratory studies funded by the American Petroleum Institute indicate that certain chemical or natural agents can be used to protect shoreline or marsh areas from oil contamination. These agents can be applied to a shoreline or marsh before an oil slick is brought ashore by wind and tides and thereby provide a protective barrier to prevent the shoreline and marsh area from becoming oil-contaminated. The objectives of the current research program are to evaluate in the laboratory and under full-scale field conditions the effectiveness of previously identified surface treatment agents in protecting shoreline and marsh areas from oil contamination. The evaluation includes methods and ease of agent application, longevity of the agents on various substrates, effects of climatic conditions on the use of agents, the environmental effects of agent use, and the logistics and costs involved in applying agents to shorelines.

36822 Hackensack estuary oil spill: cutting oil-soaked marsh grass as an innovative damage control technique. Mattson, C.P. (Hackensack Meadowlands Development Commission, Lyndhurst, NJ); Vallario, N.C.; Smith, D.J.; Anisfield, S.; Potera, G. pp 243-246 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

On May 26, 1976, a two million gallon oil spill, originating at a riverside tank farm in Jersey City, New Jersey, struck the Hackensack River estuary. Booms failed and the oil moved upriver, coating shores, marshes, creek banks, bulkheads, marinas, and the Sawmill Creek Wildlife Management Area. On-going hydrology research in velocity and water distribution patterns provided for predictability of slick movement. Search for corrective measures and the advice of a network of scientists led to implementation of an innovative grass-cutting technology. Analysis from the current five month perspective indicates the advisability of a quickly-implemented cutting operation where tidal flushing is poor, and the high potential for natural cleansing where oil has reached low-lying, well-washed marsh areas.

36823 Distributed reusable-sorbent oil recovery system. Shaw, S.H. (Seaward International, Inc., Falls Church, VA); Dorrler, J.S. pp 247-250 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

This paper describes the design, fabrication and test of a prototype system for the recovery of spilled oil from the surface of river, estuarine and harbor waters. The system uses an open cell polyurethane foam, in the form of small cubes, to absorb the floating oil. The system is highly mobile and is capable of being transported in two pickup trucks. The sorbent is distributed onto the oil slick by means of a pneumatic broadcaster. An inclined, open wire-mesh belt conveyor is used to remove the saturated sorbent from the water. The recovered oil and water are removed from the sorbent by squeezing in a converging belt press, or regenerator. After regeneration, the foam is reapplied to the oil slick. The foam is capable of being reused for more than 100 cycles. Tests of the system, using both diesel fuel and lubricating oil, were conducted at the Environmental Protection Agency's OHMSETT test tank. The sweep speeds ranged up to five knots in both calm water and in waves. System throughput efficiencies ranged from 45 percent to nearly 100 percent. Oil collection rates of up to 2,300 gal/hour were achieved. The oil content of the recovered liquid varied from 38 percent to 79 percent.

36824 Offshore mechanized sorbent oil recovery system using vessels of opportunity. Brunner, D.E.; Der, J.J.; Hall, D. pp 251-254 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

An experimental prototype offshore oil recovery system for use on vessels of opportunity has been developed by the Civil Engineering Laboratory under the sponsorship of the Navy's Supervisor of Salvage. The system is based on the concept of mechanized broadcasting, harvesting and recycling of polyurethane sorbent chips. A two-component, drop-type sorbent broadcaster was designed to uniformly distribute the sorbent in the high wind and wave conditions expected in the open ocean. Theoretical analyses of vessel motion indicated the harvester can be rigidly mounted to a barge-type vessel but that at least vertical articulation is required when mounted on an offshore work boat. The experimental prototype was functionally tested at sea without oil. The tests indicated that the waves and surface currents generated by the vessel can increase the interaction between the sorbent and the oil and enhance the sorption process. The tests also aided in identifying the characteristics of the sorbent required for use in a system of this type.

36825 Effectively recovering oil spills to groundwater. Dennis, D.M. (Michigan Dept. of Natural Resources, Lansing). pp 255-258 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

Oil spills which do not reach surface waters are often given little consideration. These spills are frequently the most difficult to clean up and pose a threat to human health and well-being by virtue of contamination of potable water supplies and release of explosive vapors in houses or commercial establishments. The cleanup is nearly always more time consuming and expensive. Three methods have been used successfully for recovering hydrocarbons from groundwater. The area of contamination must first be established by use of observation wells. The recovery wells consist of 12-to-16 in. wells pumped to waste to create a cone of depression and cause the hydrocarbons to accumulate in that cone. A skimmer pump located either within the drawdown well or directly adjacent to it pumps the product to storage. In areas of high groundwater (less than 10 ft to water), a recovery trench may be used to recover product from groundwater. This method employs a trench dug into the groundwater with an impervious barrier to prevent movement of hydrocarbons beyond the trench. A tile laid in a bed of stone in the trench leads to a pumping system; the product is then pumped to storage. In areas of little groundwater movement and high groundwater (less than 12 ft to water), a crock recovery system can be used. This system consists of concrete dry well sections with holes in the wall. These sections are placed in the ground in the area of heaviest concentration of product. The system can be used most effectively by pumping water at a rate which will lower the groundwater about 12 in. and placing a skimmer pump in the crock, or by periodic removal of product with a vacuum truck.

36826 Practical recommendations for oil spill debris disposal. Farlow, J.S. (Environmental Protection Agency, Edison, NJ); Ross, D.E.; Landreth, R. pp 265-267 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

Many oil spill cleanup efforts include the disposal of a significant quantity of unusable oily organic and inorganic debris. Because spills are emotion-charged events, debris disposal is often impeded by the somehwat exaggerated fears of local inhabitants. The U.S. Environmental Protection Agency retained SCS Engineers, Inc. to prepare a detailed, practical how-to-do-it manual for oil spill debris disposal and to make an accompanying film for state and local officials. The work included a literature search, interviews with both researchers and practitioners, and limited field studies in California, Utah and Rhode Island. Because aerobic conditions result in relatively rapid microbial degradation of the bulk of the hydrcarbons,

the land-spreading process is recommended where debris size characteristics and access to suitable land permit. Anaerobic disposal in individual burial sites or existing sanitary landfills is acceptable, though definitely less desirable because of the greatly extended period for groundwater pollution potential and monitoring.

36827 Debris handling system for Navy harbor oil spill cleanup operations. Nadeau, P.F. (Naval Facilities Engineering Command, Alexandria, VA). pp 271-275 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

Harbor debris, such as seaweed, discarded wood, and trash, can severely hamper harbor oil spill cleanup operations. Conventional harbor oil skimmer systems are not designed to handle oily debris, and therefore lose much of their utility when confronted with debris situations. To combat this operational problem, the U.S. Navy initiated the development of a debris handling system for installation on Navy oil skimmers. The final system design consists of a comminutor/grinder to process the collected oil and debris into a pumpable slurry, a positive displacement, progressive cavity pump to transfer the slurry to storage, and a one-half ton electric crane and air actuated clam-shell bucket to remove unprocessed debris from the skimmer. The grinder and bucket can process 1,200 to 1,800 pounds of oily debris per hour, depending on the mode of operation being utilized. The complete system has been thoroughly tested and evaluated, and is now operational on several Navy harbor skimmers. The system has enhanced the operational flexibility of these skimmers, and improved the overall cost effectiveness of oil spill cleanup operations. This paper traces the development of the debris handling system, specifically discussing: the harbor debris problem; various approaches for handling oil debris; system selection, design, and evaluation; and final system installation and operation. The system components are discussed in sufficient detail to provide a basis for incorporating similar debris handling systems on future harbor oil skimmers.

36828 Black oil disposal techniques. Wise, N. (Environmental Protection Agency, Philadelphia); Brunk, P.A. pp 277-279 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

One of the most complex and frustrating problems encountered in any oil spill is the disposal of recovered product. This paper will discuss an alternative utilizing relatively simple and inexpensive techniques as developed in the Chesapeake Bay Spill of February 1976, in which 125,000 gallons of contaminated black oil was burned at a total cost of $7,000. This is not, however, an endorsement of burning as a more desirable method, nor an endorsement of any particular product or brand, but rather a "limited application" technique to be considered where warranted. Indeed, the varying degrees of air pollution problems generated and their effect on ambient air quality standards may preclude any burning at all. Other alternatives must be considered, which could be more feasible or acceptable, depending on the local problems confronted in each instance. Therefore, other methods explored and exhausted before resorting to the brush burner are briefly mentioned, such as recycling, road use, burial, and a mechanical pit burner. The main thrust of this paper is the use of the brush burner, a compact gasoline powered propellar fan which forces a high volume air supply to sustain a fire hot enough to burn contaminated black oil. Given the requisite circumstances—a relatively isolated and unpolluted area, a high water table which precluded pit-burning or burial, and very large quantities of recovered product—the brush burner proved to be an efficient, convenient, and highly cost effective disposal technique.

36829 Underwater blowout oil collection. Westergaard, R.H. (Central Inst. for Industrial Research, Oslo). pp 293-295 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

Oil production in the North Sea and some other potentially important areas is much more difficult than offshore drilling was in the past. It is assumed that the difficulties are properly compensated so that blowout probability is not increased. The very much higher productivity of the wells, the expected longer duration of a blowout and the greater difficulties of surface containment obviously increase the probable oil spill volume. Exactly how much it is increased statistically is not known. A factor of 100 is suggested. For this reason, such areas need a much better oil spill defense than used in the past in other areas. The author is engaged in a feasibility study on underwater collection for control of underwater blowouts. The proposed equipment consists of a heavy submersible rig wheich can place a collection bell over the blowout orifice; the petroleum is then ducted from the bell to a surface vessel where the gas is burned and the oil collected or burned.

36830 Development of an oil spill recovery system for Artic operations. Scharfenstein, C.F.; Hoard, M.G. (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA). pp 301-302 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

U.S. Coast Guard sponsored tests at Homer, Alaska (1973), and at ARCTEC, Inc., Columbia, Maryland (1975), have shown the capability of the Lockheed disc-drum oil recovery system to operate and recover oil in broken ice conditions in arctic environments. The Homer tests were reported on film at the 1975 Oil Spill Conference and the ARCTEC work was reported by Lt. Cdr. James H. Getman, USCG, and Lawrence A. Schultz at the 1976 Offshore Technology Conference (Paper No. 2695). These studies, plus others sponsored by a Canadian offshore drilling company and Lockheed, provided data for the design of an arctic oil spill recovery vessel which incorporates a unique ice-processing subsystem. This paper presents the previously unreported results of the Canadian and Lockheed tests, and discusses the design of the arctic vessel, the ice processor, and plans for use of the equipment in arctic oil spill control operations. One such unit was delivered in June 1976 to a Beaufort Sea driller and two more were delivered to the U.S. Coast Guard last fall.

36831 Field evaluation of oil spill recovery devices. Solsberg, L.B. (Environmental Protection Service, Ottawa). pp 303-307 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

During the past three years, the Research and Development Division of the Environmental Emergency Branch of Environment Canada has undertaken the field evaluation of 10 generic classes of commercially-available oil skimmers. Included in this program was the examination of three prototype machines developed in Canada. The field trials were designed to allow for the assessment of the skimmers in actual operating conditions in both summer and winter environments. In this regard, three petroleum types—bunker, crude and diesel oil—were used in testing the mechanical devices under study in the coastal harbours of Halifax, Vancouver and Victoria and in the St. Lawrence River at Quebec City. Results indicate that for contained spills, a sorbent rope system, a hydroadjustable weir and oleophilic disc skimmer exhibited relatively higher oil recovery rates. A sloping weir device with oil/water separation capability was determined to be effective in a current situation over a range of sea states. For an uncontained slick or stiuation which would otherwise require the use of a mobile skimmer, an inverted oleophilic endless belt appeared to be the most versatile device tested. Other skimmers tested were determined to be effective for the recovery of specific oil types in more narrowly-defined conditions.

36832 Application of existing oil spill abatement equipment to cold regions. Schultz, L.A.; Deslauriers, P.C. (ARCTEC, Inc., Columbia, MD). pp 309-311 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

The increased interest in, and development of, arctic petroleum resources has increased correspondingly the potential for oil spills in cold regions. A recently completed survey of cold regions oil spill mitigation technology included a cursory determination of the applicability of presently available means to the problems of detection, containment, recovery, temporary storage, and disposal of oil spilled in cold regions. For purposes of the study, cold regions were characterized by the existence of low temperatures and the presence of ice in its many forms. The evaluations were based upon the experience of the authors in conducting other cold regions laboratory and field programs, and the experiences of others in cold regions as reported in the technical literature. This survey revealed that, while a very limited degree of oil spill response capability is available for use in cold regions based upon using the techniques and equipment currently employed in warmer climates, a great deal of development work must be undertaken before a total cold regions oil spill response capability will be available. Current technology falls

far short of the desired capability in all functional areas including remote sensing, containment, recovery, temporary storage, and disposal.

36833 Arctic offshore oil spill countermeasures with emphasis on an oil and gas blowout in the Southern Beaufort Sea. Thornton, D.E.; Ross, S.L.; Logan, W.J.; Ross, C.W. (Environment Canada, Ottawa). pp 313-319 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

A summary is presented of a review of arctic offshore oilspill countermeasures which was prepared by Environment Canada as one of the 33 projects comprising the government/oil industry-funded Beaufort Sea Environmental Program, initiated in 1974 to assess the potential impact of exploratory drilling for oil from drillships in the southeastern Beaufort Sea in 1976. Preliminary findings also are included from a study utilizing ice-movement data to predict the fate of oil from an underwater oil and gas blowout in the Beaufort Sea ice transition zone between the stationary landfast ice and moving polar pack. From field work on ice porosity in 1976, it is surmised that most oil discharged under multi-year ice will likely migrate to the ice surface within one year during the summer and early fall months. An outline is given of arctic offshore oil spill countermeasures projects which have been initiated to develop efficient methods of combusting oil on ice; to evaluate the effectiveness, fate and effects of dispersants in cold sea water; to develop effective dispersant deployment methods in ice-infested waters; and to generate innovative ideas for containing oil from underwater blowouts.

36834 Development of a high current streamlined oil boom/skimmer for inland waterways. Folsom, B.A.; Johnson, C. (Ultrasystems, Inc., Irvine, CA). pp 323-327 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

The streamlined oil boom/skimmer uses a slightly submerged slotted hydrofoil to skim a thin layer of oil and water into an attached sump where kinetic energy is dissipated, the oil and water are separated and the oil is retained and recovered. Because of the system's simplicity and low drag, it can be deployed as a high speed skimmer supported by a catamaran or as a high current boom with several adjacent sections spanning a high current area. Earlier work, reported in the 1973 Joint Conferences on the Prevention and Control of Oil Spills, included preliminary feasibility tests, in which the potential for excellent high current performance was demonstrated and small-scale bow wave tests. The work reported here includes applying the previous results to full-scale models, refining sump design, developing a stability control/flotation system and integrating these subsystems in a pre-prototype model for testing at OHMSETT.

36835 METULA oil spill. Gunnerson, C.G.; Peter, G. Boulder, CO; National Oceanic and Atmospheric Administration (1976). 41p. (In English and Spanish). .

In August 1974 the supertanker METULA ran aground in the Strait of Magellan and spilled over 50,000 tons of light Arabian crude oil. The spill was not contained and the oil was carried over large segments of beaches and tidal marshes of Tierra del Fuego, and deep into the estuaries of the area. Findings of a team of scientists from the United States and Chile, who investigated the environmental damage in August 1974 and again in January 1975, and of others who discussed the spill at a workshop, are summarized. Included are the background of the accident, the physical environment, the reasons why cleanup measures were not attempted, and the most important follow-up research needs. The research results will be used to identify critical environmental information that can be transferred for use in planning and for predicting environmental impacts in other similar areas of the world.

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 36794, 36811, 36813, 36817, 37552, 37553, 38128, 38132

36836 Workshop for defining the role of local governments in oil spill response. Putnam, W.H. (State of California Resources Agency, Long Beach). pp 125-127 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

In 1970, the National Oil and Hazardous Substance Pollution Contingency Plan was introduced. This plan, which imposed a planning sequence that flowed downward from the federal government, caused considerable confusion at local levels because of its failure to fully explain how local governments were to participate. To amplify the plan and overcome this shortcoming, the California Department of Fish and Game, the U.S. Coast Guard and the petroleum industry joined in 1974-1975 to sponsor a series of oil spill workshops for local governments. The goal was to define the role of local jurisdictions in the planning process and illustrate through simulated problems how this role was to be carried out. The workshop described in this paper and a subsequent workshop in Santa Barbara dispelled the confusion of local governments over their roles in oil spill action and resulted in enthusiastic acceptance of the plan itself. A similar technique could be used in any other broadscale planning effort that is committed to seeking knowledgeable local participation.

36837 Oil spill control training: Texas A and M University's approach. Payne, J.L. (Texas A and M Univ., College Station). pp 129-133 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

Developed initially by Texas A and M's Civil Engineering Department in 1974 through a grant from the American Petroleum Institute, the five-day oil spill control course was subsequently turned over to the Texas Engineering Extension Service for implementation. Currently the course is offered at facilities in Galveston, Texas. Flexibility within the curriculum allows the course to be directed toward non-industry personnel as well as personnel directly involved in oil production. Techniques current in industrial education, such as the spiral-step method of instruction, are employed throughout the course. Also, the course emphasizes practical training and is unique in its hands-on capabilities. The curriculum, subject to keen scrutiny, is continuously improved and updated. Moreover, the success of this program has encouraged the development of other specialized and refresher courses.

36838 Spill training and education program at Texas A and I, Corpus Christi. Gilchrist, R.E. (Texas A and I Univ., Corpus Christi). pp 135-136 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

The object of the week-long Spill Training and Education Program at Texas A and I at Corpus Christi is to enable the student to accomplish the following for the home community: recognize the exposure to oil spill of the home community, determine the equipment and techniques necessary to clean up an oil spill, prepare a contingency plan to meet the needs of the community, recommend the vehicle needed to carry out the contingency plan.

36839 Canadian approach to oil spill training. Kay, G.H. (Ontario Ministry of the Environment, Toronto). pp 137-138 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

The oil industry and governments in Canada are very conscious of the need to initiate and continue training to prevent and control spills. It was believed that such training could be improved if input would be obtained from both sectors in joint productions rather than if each worked independently. Early in 1973 the Consortium on Spill Training (COST) was formed. Representation continues to be from industry and the federal and provincial governments. The purpose of the consortium is to produce spill training aids. Videotape cassettes (¾-inch, 26 minutes) have been prepared on the following: "Spill in a Creek," "Contingency Planning Guidelines," "Public Relations at the Spill Scene," and "Safety at the Spill Scene." In process are "Boom Deployment" and "Shoreline Protection and Cleanup." A documentary film of a simulated oil spill exercise was prepared. The improved quality of the aids confirms the advantages of joint rather than independent productions. The training aids are available in English and French at cost.

TRANSPORT, PIPELINES, AND HANDLING

REFER ALSO TO CITATION(S) 36812, 36820

36840 ASEA marine automation equipment for eight shell products tankers. Rodsten, S.; Lofgren, A. (Allm Sven Elektr, Oslo, Norw). *ASEA (Allm. Sven. Elektr. A. B.) J.;* **50**: No. 4, 85-91(1977).

The international oil company Shell has recently taken delivery of a series of eight 30,000 tdw products tankers. These ships are unique in that they have a 3.3 kV auxiliary power plant and electrically driven cargo pumps. Other special features are the absence of any kind of steam raising plant and the use of two medium-speed engines driving a common gearbox for both propulsion and power generation for the cargo pumps and the general ship's service. The article describes the complete automation equipment delivered by ASEA for these ships.

PROPERTIES

REFER ALSO TO CITATION(S) 36818, 38090, 38106, 38112

36841 Strontium isotopic composition of several oilfield brines from Kansas and Colorado. Chaudhuri, S. (Kansas State Univ., Manhattan). *Geochim. Cosmochim. Acta;* **42**: No. 3, 329-331(Mar 1978).

The $^{87}Sr/^{86}Sr$ ratios of several oilfield brines associated with Paleozoic dolomites, cherty dolomites and sandstones from Kansas and Colorado range from 0.7113 to 0.7341. Two brines in the Mississippian dolomites from Colorado were found to contain the most radiogenic strontium. The $^{87}Sr/^{86}Sr$ ratios of brines in a small oilfield in eastern Kansas are constant, and the ratios may suggest that in this field there may be only one oil pool. The isotopic composition of strontium in subsurface waters could be useful in determining hydrologic continuity among reservoirs and for obtaining additional information on the origin and migration of these fluids.

36842 Investigation of the microelement composition of petroleums of the anastasiyevsko-troitskoye deposit. Berkutova, I.D.; Yakubson, K.I. (Moscow Inst of Petrochem and Gas Ind, im. I.M. Gubkin, USSR). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 7, 11-15(1977). (In Russian).

The contents of Co, As, Ga, Br, Cu, Mn, and Na in petroleum originating from different beds of the investigated deposit are determined by the neutron activation method. Elevated concentrations of Co, As, and Ga have been discovered. Results are obtained indicating a comparatively early (prior to the formation of the beds in their present form) introduction of Co into oil. Based on a comparison of the Co, As, Ga contents and their ratios in oil and the concentration of Co in asphaltenes, conclusions are drawn about the possibility of a common genesis of the beds and of the entire deposit as a whole. 11 refs.

36843 Effect of Ishimbay and Mangyshlak petroleums on stability of reverse concentrated emulsions and complexing of urea with n-paraffins. Ivanov, P.L.; Chegodaev, F.A.; Abzalov, R.M.; Klimenok, B.V. (Ufa Pet Inst, USSR). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 7, 55-57(1977). (In Russian).

An investigation is carried out into the effect of the content of petroleum in a mixture with n-paraffins on the stability of concentrated emulsions of the "water-in-oil" (W/O), type and of the concentration of the emulsion on the complexing rate. It is found that stability of concentrated emulsions, depending on the content of petroleum in the oil phase passes through a maximum. The Ishimbay oil stabilizes the W/O emulsion better than the Mangyshlak oil. The rate of urea complexing with n-paraffins increases with the rise in the concentration of the emulsion. In emulsions with the Mangyshlak oil, complexing takes place faster than with the Ishimbay oil.

36844 Thermal properties of benzene and toluene in the saturation state. Akhundov, T.S.; Abdullaev, F.G. (Az SSR Inst of Pet and Chem im. M. Azizbekov). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 7, 64-68(1977). (In Russian).

The results of measurement of the P-v-T relation of benzene and toluene in the vapor, two phase, and liquid phase are processed by means of graphical analysis. The values of V'j and v'' of these substances in the temperature range from 298.15 K to the critical temperature T$sub cr$ are determined. Equations of state for the vapor and liquid phase separately are set up for the description of the P-v-T relation. Single interpolation equations are set up for vapor elasticity. The values of the heat of vapor formation are calculated. 15 refs.

36845 Effect of electric field on oil viscosity. Fedorov, E.E.; Fedorova, M.G. (Ivano-Frankovskii Inst of Pet and Gas, USSR). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 7, 80-82(1977). (In Russian).

Results of experimental investigations concerning the dependence of oil viscosity on the voltage between coaxial electrodes, creating both a constant and a variable electric field in oil during crystallization of its solid hydrocarbons are presented. It is found that a constant field results in a slight decrease in oil viscosity. When oil is acted upon by a variable field with the frequency of 50 Hz, an increase of voltage results first in a reduction of oil viscosity by a half and subsequently in an increase of viscosity. The possible mechanism of the field effect on oil viscosity is considered.

36846 Water soluble components of crude oils, fuel oils, and used crank-case oils. Winters, K.; Parker, P.L. (Univ. of Texas Marine Science Inst., Port Aransas). pp 579-581 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

The major components of water soluble fractions (WSFs) prepared from representative crude, fuel, and used crankcase oils have been identified by combined gas chromatography-mass spectrometry. Classes of hydrocarbons identified include alkyl phenols, anilines, indoles, quinolines, and benzothiophenes. Aromatic aldehydes and ketones were also identified. The composition of freshly prepared WSF and WSF exposed to air for from 6 hours to 5 days was determined. Alkyl benzenes, indans, and naphthalenes were rapidly lost from solution with negligible concentrations remaining after 24 hours. In contrast alkyl phenols, anilines, and indoles were generally present at greater than 50 percent of their initial concentration after 5 days.

36847 Photo-oxidation of crude oils. Nagata, S.; Kondo, G. (Kobe Univ. of Mercantile Marine, Japan). pp 617-620 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

Changes with elapsed time are presented for five kinds of oils that were studied through the analyses of GLC method, where particularly we made an attempt to examine the relationship among specific gravity, viscosity, and the amount of water in oils. Furthermore, we tried to evaluate a few processes of various kinds of changes on the physical and chemical properties of oils such as evaporation, biodegradation, and photo-decomposition. The evaporation process was found to affect mainly paraffins with smaller boiling points, below the number of C_{12}-C_{13}, for 21 days, while due to the action of marine bacteria, normal paraffins were effectively degraded (Ca, 50 percent) after 15 days except for branched ones. Moreover, it was also found that the aromatic hydrocarbons with anthracene ring and heteroaromatic ones, which were not easily decomposed by the processes mentioned above, were fairly decomposed by photo-irradiation for 10 hours.

36848 Liquid chromatographic fluorescence technique for estimating crude oil in water, sediment, and biological material. Miles, D.H.; Coign, M.J.; Brown, L.R. (Mississippi State Univ., Mississippi State). pp 179-182 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

This paper presents a method for the rapid detection of crude oil in the presence of large amounts of biological material. The method involves the use of high pressure liquid chromatography with chloroform as the solvent, an excitation wavelength of 403 nm, and an emission wavelength in the range of 418 nm. Of the five crude oils employed in this investigation, Saudi Arabian crude oil was the least responsive to the above technique and yet is still detectable in quantities of less than 1 μg. Reproducibility studies indicated that the percent error of repetitive injections of Saudia Arabian crude oil samples was 1.3 percent. Repetitive injections of spiked shrimp samples gave a percent error of 3.7 percent. This is excellent reproducibility for residue-type samples which undergo a number of manipulations during workup. Thus, this method is selective, sensitive, reproducible, and affords a rapid analysis.

STORAGE

36849 (CONF-770440—, pp 270-278) **Strategic oil storage requirement and costs for the United States: some economic observations.** Copp, E.A. (Salomon Brothers, New York). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

The strategic oil storage program for the United States is likely to be costlier than initially estimated, due to higher crude oil costs, higher costs of facilities, and a shortening of time frame allowed to achieve targeted storage levels of alternative crude oils. Previous storage studies have concentrated on finding the particular storage type which was the least costly. Many of these studies have implicitly assumed that all oil stored for emergency use would then be stored in this one type. Exceptions to this are recent National Petroleum Council studies and studies by the Federal Energy Administration. A goal programing model for emergency storage has indicated that the least costly mix of oil storage would combine uses of both salt domes and abandoned mines over other options. The timing profile of using other storage techniques as the size of the strategic program increases over the next ten years also results from this model. The cost of a 5,000,000 barrel reserve is likely to be greater than government estimates of $7.5 to $8 billion.

36850 (CONF-770440—, pp 279-282) **Meeting the mined underground storage requirements for the national strategic crude oil storage program.** Brandt, C.T. (Fenix and Scisson, Inc., Tulsa, OK). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

In 1975 the U.S. Congress authorized the construction of 500 million barrels of underground strategic crude oil storage. 150 million barrels are to be in place by December of 1978, 350 million barrels to be in storage by December of 1980, and the entire 500 million barrels to be in place and ready for use by December of 1982. Underground storage in conventionally mined caverns is not new. It has been successfully demonstrated and publicized time and time again. In volume, however, 150 million barrels is equivalent to the space in a 30 foot diameter tunnel reaching from New York to Washington, D. C. There is no way to construct, by conventional mining methods, a new facility of the magnitude within the given time frame. Nevertheless, with about 20,000 mines in the desired area, no particular conversion problems were foreseen. When investigation showed that only 11 of the 20,000 mines were found to be potentially suitable for the intended use is outlined. The differences between mining to produce rock and mining to produce a hole are identified. How the initial 150 million barrel assignment is proposed to be met within the prescribed time limit by the utilization of existing cavities created in salt domes as an end result of solution mining of sodium chloride is described.

36851 (CONF-770440—, pp 284-296) **Military implications of nuclear geostorage systems for petroleum products.** Sprague, K.E.; LaFrenz, R.L. (USMA, West Point, NY). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

In order to support large scale military operations, petroleum fuel must be supplied in large quantities and in a timely manner. Bulk storage of fuel must be provided in facilities with capacities of from 250,000 barrels to over 2,000,000 barrels to meet demand requirements with adequate reserves. The requirement for secure storage is examined and nuclear geostorage is compared with more conventional petroleum storage facilities for vulnerability of a variety of threats and found to provide greater or equal security. The envisioned nuclear geostorage systems could be constructed within situated permeable geologic formations, as well as impermeable media. Loss of petroleum fuel to the rock structure is examined and found to be within established military acceptable loss criteria. Radioactive contamination of the formation due to tritium and krypton is found to be within MPC levels Radiation damage to the fuel is shown to be negligible. Nuclear geostorage could provide the required secure storage of petroleum fuels with acceptable losses and radiation hazards.

36852 (CONF-770440—, pp 297-307) **Perspective on large scale oil storage by nuclear devices.** Crump, J.R.; Hocott, C.R. (Gulf Universities Research Consortium, Houston, TX). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

Decisions regarding large scale storage must be made in an open competition among technical, economic and political factors. The critical factors are identified and associated with both indirect and direct methods of solving storage problems. Increased coal utilization, increased drilling and the development of "overproduction facilities" are considered as methods of negating or diminishing the need for storage. Cavities in salt deposits, abandoned coal mines, and depleted sulfur mines are examined as large scale storage devices. The economic factors of storage caverns created by PNE (peaceful nuclear explosions) are stated. The viewpoint assumed is that of an industrial analysis, with a sequential comparison of alternatives examined as investments. The conclusion reached is that PNE storage may be the optimum strategy in certain cases; but that the U.S. presently is denied the "PNE option", largely because of political factors.

36853 (DOE/EIS—0010) **Strategic petroleum reserve, Sulphur Mines salt dome, Calcasieu Parish, Louisiana. Final environmental impact statement (final statement to FEA-DES-77-6).** (Department of Energy, Washington, D.C. (USA)). Mar 1978. 622p. NTIS, PC E03/MF E03.

This site-specific Environmental Impact Statement (EIS) has identified particularly sensitive environmental parameters that have been investigated in detail for the Sulphur Mines, Louisiana site. The most sensitive parameters to be affected by oil storage development at this site appear to be water quality and air quality. However, the use through several cycles at the Sulphur Mines site would be limited due to the close proximity of the caverns to the periphery of the dome. The adverse impacts to the physical environment that could result from the program include: degradation of surface water quality; a moderate increase in hydrocarbon emissions during transfer and storage of oil; locally significant increases in hydrocarbon emissions during transport of oil from the Gulf of Mexico to Sun Terminal; and the potential for an increase in the frequency of oil spills along the transportation corridors. Changes in water quality would have a short-term impact on the aquatic organisms in local areas. Oil spill releases to land and water environments could cause localized losses to vegetation and fauna. Brine disposal into subsurface aquifers appears to have the necessary total capacity to accommodate the total volume of brine to be disposed. The transfer of crude oil at Sun Terminal would have a minor adverse impact on the amount of hydrocarbons (in the form of volatile vapors) released to the atmosphere. More significant hydrocarbon emissions would occur during each fill operation. A total of 453 barrels of oil are projected to be spilled during the project lifetime in transporting the crude oil. The maximum credible spill size is 400,000 barrels for tankers and 10,000 barrels from the pipeline system. A spill of this size could severely pollute several hundred acres, depending on location, but the probability of occurrence is extremely low.

36854 (DOE/RA—0032/2) **Strategic Petroleum Reserve Plan. Expansion of the Strategic Petroleum Reserve: Amendment No. 2, Energy Action DOE No. 1.** (Department of Energy, Washington, D.C. (USA)). Mar 1978. 66p. Dep. NTIS, PC A04/MF A01.

The Amendment provisions are to provide for the expansion of the reserve size from 500 million barrels to 1,000 million barrels and an implementation plan for the third 250 million barrels and to provide for storage of petroleum products for U.S. East Coast. The Amendment describes proposed changes to the program and discusses the required implementation activities as well as the benefits and costs of the actions. The relevant economic and environmental impacts that would result from implementation are assessed. (LK)

36855 Offshore-terminal with underground storage at sea. Relotius, P.C. (Ingenieurgemeinschaft Meerestechnik und Seebau GmbH, Hamburg); Lorenzen, H.; Kaundinya, H. *Oil Gas--Eur. Mag. (Engl. Transl.);* **3**: No. 2, 39-40, 45(1977).

The present study has demonstrated the technical feasibility of the offshore terminal project. Consultation with experts lead to the belief that the remaining detail problems are solvable. However, the full realization of the project potential depends essentially on the following two factors: 1. Positive demonstration of significant cost advantages (economy). 2. Political interest in such an installation (for example, the application of this concept to common European problems of supply and storage). Whether or not one of the above factors, or possibly both, prove to be an adequate basis for implementing a full-scale offshore terminal installation depends on the economic outlook and on political considerations.

36856 Discovery, containment, and recovery of a jet fuel storage tank leak: a case history. Talts, A. (Army Environmental Hygiene Agency, Edgewood Arsenal, MD); Bauer, J.; Martin, C.; Reeves, D. pp 259-263 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

In October 1975, product accountability suggested the loss of approximately 83,000 gallons of JP-4 from a newly cleaned 3.3 million gallon aboveground storage tank at a U.S. government-owned fuel terminal. There was no visible evidence of a leak;

however, a soil investigation confirmed the presence and extent of the fuel loss. Fuel was found within the porous ground at the water table 7-to-14 ft below the surface. Quick response permitted the use of a construction site well point system to contain the leak within the tank farm by drawdown and reversal of the water table gradient. Recovery of product was accomplished by diverting the pump discharge through the dike drainage system to the terminal oil/water separator. Approximately 21,000 gallons of fuel were recovered in a one month period. High system costs and declining flow and fuel recovery rates resulted in attempts to use different systems. A large diameter excavation and a new well point system failed to recover additional fuel; it was lost to evaporation or bound within the soil for bacterial degradation. It is recommended that spill plans for terminals in areas with porous soil should include provisions for containment and recovery of potential leaks and spills from within the ground.

COMBUSTION

REFER ALSO TO CITATION(S) 37251

36857 (ORNL/TM—6184) **Effects of alternate fuels. Report No. 3. Analysis of high-duty fireclay refractories degraded by residual oil combustion products.** Wei, G.C.; Tennery, V.J. (Oak Ridge National Lab., Tenn. (USA)). Apr 1978. Contract W-7405-ENG-26. 47p. Dep. NTIS, PC A03/MF A01.

High-duty fireclay brick (approximately 39 wt% Al_2O_3) used for only six months in the soot hopper of a residual-oil-fired steam boiler, where the refractory operated at about 1400°C was analyzed. The refractory loss of this firebrick was about 30 mm and the reaction zone in the firebrick extended to a depth of 80 mm toward the brick cold end. The rate of the refractory material loss was 5 mm/month and the reaction zone front proceeded at a rate of 18 mm/month. In a natural-gas-fired boiler, this type of refractory has a typical service life of three years. The service time of the refractory was drastically shortened by reactions involving firebrick constituents with sodium and vanadium derived from the fuel oil plus calcium and magnesium from the fuel oil additives. Four principal reactions between the impurities derived from residual fuel oil and oil additives and the high-duty firebrick during service were identified. Both sodium and vanadium played an important role in the refractory degradation. The magnesia- and dolomite-based additives used in the fuel oil for retarding metal boiler tube corrosion did not impede the refractory corrosion. Zircon and corundum phases in the firebrick appear inert to reactions with fuel oil impurities and additives. Increasing the aluminia content of the refractory may produce a more viscous glassy phase to reduce fuel oil impurity-refractory reaction rate and/or introduce more corundum into the refractory to increase its resistance to fuel oil impurity corrosion.

NATURAL GAS

REFER ALSO TO CITATION(S) 36595

36858 Spravochnik ekspluatatsionnika gazovykh kotel'nykh. (Handbook on the exploitation of gas reservoirs). Stolpnera, E.B. Leningrad; Nedra (1976). 528p.

This book concerns clarified apparatus, adjustment, exploitations and repair of systems of gas supply and automations, gas equipment, being used in boilers, methods of combustion of gas in fire-chambers of boilers. Main informations are given on boilers, and thermomechanical and auxiliary equipment of boiler. The book is designated for engineering-technical workers of gas economics of industrial and communal-everyday undertakings, and also can be used by planners and by students of construction and energy specialties.

RESERVES

REFER ALSO TO CITATION(S) 36872

36859 Statistical models of formation of gas yield coefficients. Ametov, I.M.; Danilov, G.V.; Rossokhin, G.V.; Yachmeneva, V.P. (Ukhtinsk Ind Inst, Komi, USSR). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 7, 41-45(1977). (In Russian).

Statistical properties of the final gas yield coefficient of Soviet gas and gas condensate deposits are considered. It is shown that this value obeys an exponential law of distribution. Statistical models of formation of the gas yield coefficient are constructed.

GEOLOGY AND EXPLORATION

REFER ALSO TO CITATION(S) 37516

DRILLING, PRODUCTION, AND PROCESSING

REFER ALSO TO CITATION(S) 36752, 36761, 36762, 36772

36860 (CONF-770440—, pp 441-452) **Well testing techniques in hydraulically fractured formations.** Holditch, S.A. (Texas A and M Univ., College Station). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977). In Energy and mineral resource recovery.

During the last few years, a great deal of interest has been generated in the exploitation of low permeability gas reservoirs. To obtain economic production rates, tight reservoirs must be stimulated. Of primary importance to the success of these treatments is the analysis of in situ reservoir and fracture properties from well test data. At present, the methods available for analyzing well test data from fractured gas wells are not adequate. The objectives of this paper are (1) to summarize the various well testing methods that have been published, (2) to discuss the advantages and disadvantages of each of these methods and (3) to discuss the research project at Texas A and M University which is directed toward developing new analysis techniques for tight, fractured gas reservoirs.

36861 (CONF-770440—, pp 708-719) **Laboratory simulation of perforations in a deep dual-cased well.** Power, D.V.; Wilson, J.G.; Jones, A.H.; Rogers, L.A.; Owen, H.D. (Terra Tek, Salt Lake City). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977). In Energy and mineral resource recovery.

Perforation tests of dual concentric casing were performed in the laboratory using shaped charge jet perforators at near surface and deep-hole conditions for a 10,000 foot deep well in a geopressured, tight gas formation. Well completion plans required an accurate knowledge of perforation size for use of the limited entry technique in massive hydraulic fracture experiments. Tests were conducted to investigate the effects of downhole conditions on jet charge perforations. Hole size, penetration of various rock types, charge liner type, gun clearance and annular grout thickness between casings were variables investigated. Specially designed guns, pressure chamber, and target assemblies were constructed which permitted control of wellbore, pore, biaxial confining and lithostatic pressures and clearance between the gun and casing. A 14 gm explosive shaped charge employing either a solid wrought copper (Cu) or a pressed powdered copper (DML) liner resulted in a hole of about the desired dimensions at near surface conditions. Tests showed negligible differences due to potential annular grout thickness variations. Simulated downhole pressures resulted in a decrease in effective hole area by about 15 to 20% with a resulting increase in perforation pressure drop of 40 to 55%. Increasing gun clearance from 0 to 3/8 inch decreased the effective hole made by copper lined charges by 10 to 15%, but the DML charge showed an increase in hole size with increasing clearance. Copper lined charges resulted in about a 6% larger hole than DML charges. In a significant number of tests using a copper liner and a formation core target, a flared carrot was deposited at the casing hole exit which could block production flow. Based upon laboratory test results, a DML charge and field procedure were selected and used in successful field operations.

PRODUCTS AND BY-PRODUCTS

REFER ALSO TO CITATION(S) 36767, 36774, 36775, 36776, 36777

36862 Floating natural gas liquefaction plant. Meyer-Detring, D. (Preussag AG, Hanover). *Oil Gas--Eur. Mag. (Engl. Transl.);* **3**: No. 2, 15-16(1977).

Floating LNG plants offer a technically feasible and economical method to produce natural gas from marginal offshore fields and are under certain circumstances an economical alternative to land-based LNG plants. The presented floating, semisubmersible plant can keep up production under northern North Sea conditions all the year round.

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 37554

36863 **Soviet Union's foreign trade in natural gas.** Fischer, A.K. *Oil Gas--Eur. Mag. (Engl. Transl.);* **3**: No. 2, 9-14(1977).

For a long time the Soviet Union's natural gas industry was overshadowed by other sources of primary energy. It was a latecomer and in 1965 not more than 9% of capital expenditure was allocated to it from the energy industry's budget, although the proportion of the country's primary energy production was, even in those days, as much as 16%. So it is not surprising that foreign trade in natural gas also began very late. One contributory factor was that natural gas can only be transported in pipelines in the Soviet Union, although road and railway tankers can be used, for example, for mineral oil. The 10 mrd m^3 mark for imports was passed for the first time in 1972 and for exports in 1974.

36864 **Natural gas projects in Iran.** Pasdach, U.J. (Embassy of the Federal Republic of Germany, Tehran, Iran). *Oil Gas--Eur. Mag. (Engl. Transl.);* **3**: No. 2, 25-28, 31-32(1977).

Estimates of natural gas reserves in Iran show Iran to have the second largest gas reserves in the world, after the Soviet Union. Present and future development is discussed. No new export projects are now being planned for the time being; emphasis will be placed on the home market for Iranian natural gas. There are three large pipeline projects in progress in Iran: IGAT II, Qeshm, and Sarakhs-Neka. Expansion of urban and rural gas supply is planned. Gas will also be injected for secondary production of crude oil. Finally, the organization of the Iran gas industry is described. (DLC)

WASTE MANAGEMENT

36865 **Behavior of dolomite in absorption of H_2S from fuel gas.** Harvey, R.D.; Kan, G.; Graff, R.A.; Squires, A.M. pp 163-188 of World mining and metals technology. Vol. 1. Weiss, A. (ed.). New York; American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc. (1976).

From Proceedings of the joint MMIJ-AIME meeting; Denver, CO, USA (1 Sep 1976).

See CONF-7609165—P1.

Particles of half-calcined dolomite ($CaCO_3$ + MgO) that had undergone cyclic absorption of H_2S and regeneration with CO_2 in laboratory tests reveal enlargement of the crystallite grain structure, reduction in the number of pores but enlargement in their size, and partial development of a relatively dense mosaic microstructre on outer surfaces of cyclically reacted particles. Scanning electron microscopy, x-ray microanalysis, microprobe analysis, and x-ray diffraction techniques were used to evaluate microstructural properties of particles after tests conducted at pressures of 1 and 21 atm and temperatures of 700 to 900°C. The tests conducted at 750°C and 21 atm showed the most favorable absorption and regeneration capacities of the dolomite tested. The changes in structure and pores play a major role in reducing the sulfur reactivity of half-calcined dolomite particles. The mosaic microstructure forms more rapidly at 1 atm than at 21 atm pressure. Once it occurs it seals the surface of the natural pore channels that existed in the half-calcined dolomite and restricts further conversion of crystallites of $CaCO_3$ within the particles. Although a relatively coarse, granular mosaic of crystallites is present on some particles cycled at 21 atm pressure after only three absorption-regeneration cycles, it does not completely cover the particles, and that is true even after 30 cycles. Individual crystallites of MgO were not resolved by the x-ray microanalysis, but it is believed that during the tests the MgO occurs as crystallites no more than 0.1 μm in diameter that are homogeneously distributed through the particles, and it remains essentially inert during the reactions. The MgO contributes to the maintenance of the original fine-grained and microporous structure of the particles, an effect that is most advantageous to absorption and regeneration.

ARTIFICIAL STIMULATION, PLOWSHARE, ETC.

REFER ALSO TO CITATION(S) 36749, 36762, 36860, 38324

36866 (CONF-770440—, pp 707) **Pressure analysis for a massive hydraulic fracture.** Randolph, P.L. (Inst. of Gas Tech., Chicago). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

This paper presents an analysis of a heavily instrumented, 1975 MHF experiment performed in the northern Green River Basin by El Paso Natural Gas Company and ERDA. Limited entry was used to simultaneously fracture six sandstones between depths of 10,100 and 10,800 feet with about 450,000 gallons of gelled water and 1,400,000 pounds of sand. Although quantitative data was not adequate to obtain a unique solution, the analyses to be presented strongly suggest the following. (1) Friction pressure of gelled water moving through 4.0 inch ID casing at 45 pbm approximately doubled as sand concentration was increased from zero to four pounds per gallon. (2) Little, if any, perforation erosion resulted from pumping about 8850 pounds of 100 mesh sand through each perforation. But, that amount of 20/40 sand decreasd perforation pressure drop by an amount equivalent to increasing the orifice coefficient from 0.50 to 0.95. Erosion then continued at a much lower rate. (3) After pumping ceased, flow through the casing due to closure stresses differing by more than 1500 psi redistributed proppant between the multiple sandstones.

36867 (CONF-770440—, pp 415) **Prop transport considerations in the design of massive hydraulic fracturing treatments.** Clark, P.E.; Harkin, M.W. (Dow Chemical U.S.A., Tulsa, OK). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

Massive hydraulic fracturing treatments have met with some success in the stimulation of tight gas sands. The process of improving the success ratio involves a very careful analysis of all of the variables that affect the fracturing process. One of the more difficult variables to obtain good estimates for is the proppant transport characteristics of a fluid under downhole conditions. Effective fracture propping is a dominant factor in the success or failure of a fracturing treatment. Some of the factors that affect prop transport are fluid velocity, fluid viscosity, fracture width, prop density and prop diameter. Of these, only a few can be estimated with any accuracy. Methods of estimating the important parameters and minimizing the errors due to these parameters will be discussed. General design concepts and temperature effects will also be covered.

36868 (CONF-770440—, pp 417-428) **Massive Hydraulic Fracturing Gas Stimulation Project.** Appledorn, C.R.; Mann, R.L. (CER Corp., Las Vegas, NV). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

The Rocky Mountain massive hydraulic fracturing experiment was fielded in 1974 as a joint government-industry demonstration to test the relative effectiveness of massive hydraulic fracturing in gas-bearing formations that were stimulated by the Rio Blanco nuclear fracturing experiment. The target formations in the project area, the Fort Union and Mesa Verde, are 4000 ft thick and estimated to have 74 billion cu. ft of gas in place per square mile. The potential reservoirs are lenticular shaly-silty sands in a thick section of shale and siltstone. The fracturing experiments are designed to interconnect these sand lenses with vertical fractures extending 80 to 200 ft in height and up to 2500 ft laterally from the wellbore. Extensive coring, logging, and testing of the well during and after completion provided initial data for fracture design. The reservoir and physical characteristics of the rock are typical of the tight gas-bearing sands in the Western Rocky Mountain Basins; the shaly-silty sands have permeability in the low microdarcies, relatively high connate water saturations, and gradational contacts between shales, siltstones, and sands that provide little impedance to vertical propagation of fractures rather than the preferred horizontal propagation. Four fracturing experiments have been performed: two in the Mesa Verde and two in the Fort Union. The maximum longer-term postfrac to prefrac producing ratio obtained to date has been roughly 3 : 1, though higher ratios have prevailed initially. The experiment is being conducted to determine fracturing techniques that will be effective in developing additional natural gas resources from the Western Rocky Mountain tight gas sands.

36869 (CONF-770440—, pp 429-440) **Stimulation experience in the Wattenberg Field, Colorado.** Covlin, R.J. (Amoco Production Co., Denver); Holman, G.B.; Fast, C.R. 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

The results of stimulation experience in the Wattenberg Field to develop the gas potential from the very low permeability Muddy "J" formation are presented. Based on the success of this experience in Wattenberg exploitation of similar "tight gas reservoirs" is quite probable. The Muddy "J" Formation is approximately 50 ft thick and found at a depth of about 8,000 ft. Initial stimulation attempts were made by stimulating wells with 40,000 to 50,000 gal gelled water fracturing treatments. These efforts resulted in increased gas production; however, the rapid decline of gas production rates with time indicated that the stimulations would be economic failures. Laboratory studies were made to evaluate various fracturing fluids and to investigate fracture flow capacity with various proppant plans. Using these studies, a MHF (Massive Hydraulic Fracturing) stimulation program was developed which utilized a polymer emulsion fracturing fluid. Field case histories are discussed and the results of MHF treatments are compared with the earlier fracturing treatments. It was found that MHF is an effective method for the development of gas potential when appropriately applied. Well and

treatment payout time is inversely proportional to the treatment size in the better areas of the field showing that the larger treatments are more desirable than the smaller ones. In the poorest areas of the field, well and treatment payout is indefinite at the current interstate gas price.

36870 (CONF-770440—, pp 453-457) **Enough economic incentive + bold technology = gas for U.S.A.** Ellison, L.F. (Sun Production Co., Dallas). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

Hydraulic fracturing was first introduced by the oil and gas business some 30 years ago to improve productivity of tight zones that were normally uneconomical. This stimulation process has added huge volumes to the U.S.A.'s recoverable reserves. And over the years the fracturing process has become highly technical and sophisticated due to deeper, more difficult and broadly varying applications. South Sarepta Field in Northwest Louisiana is one of the most recent examples of how Sun Production Company pioneered new fracturing concepts and methods to successfully stimulate commercial gas production from the deep, hot, high pressure Smackover Gray Sand. The South Sarepta Field is located in northeastern Bossier Parish and northwestern Webster Parish, Louisiana, about 10 miles south of the Arkansas-Louisiana boundary. The Gray Sand, a member of the Smackover Formation of Jurassic age, has been known to be gas-bearing for some time in this field. However, it was not until the advent of modern fracturing techniques and a significant rise in the price of natural gas that this formation was capable of sustaining commercial gas production. The main portion of this paper is a discussion of the engineering developments which have made commercial gas production possible from the Gray Sand. As a result, these techniques have made available a major new source of gas reserves in North Louisiana.

TRANSPORT, PIPELINES, AND HANDLING

REFER ALSO TO CITATION(S) 37041, 37580, 37837

PROPERTIES

REFER ALSO TO CITATION(S) 36660

36871 **Program for unified methods of control of the quality of natural gas in the CMEA countries.** Sedlar, J. *Cesk. Stand.;* **2**: No. 8, 295-296(2 Aug 1977). (In Czech).

Natural gas has certain unique advantages as a fuel. For such applications it must be imported into Czechoslovakia; the main supplier of the gas will be the USSR, but some Iranian supplies are also planned. The standards of the CMEA countries will also include a Natural Gas Standard number 8.1.4. The Standard will include a chromatographic method gas analysis, determination of methanol, determination of Wobbe's number, heat of combustion and density, determination of H_2S, mercaptans, and of total S, determination of solid particles, higher hydrocarbons, condensates, water vapor, and dew point. Safety precautions, methods of gas distribution, and other aspects will also be eventually covered by the Standards. The problems will be solved within the framework of the International Organization for Standards in the Technical Commission 158 "Gas Analysis."

36872 **Investigation of the viscosity of gas condensates of some Turkemenian SSR deposits at different temperatures and pressures.** Abdurakhmanov, A.; Mutalibov, A.A.; Shubin, V.V. (Tashkent Highw Inst, Uzb SSR). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 7, 69-72(1977). (In Russian).

Using the capillary viscosimeter method, the viscosity of gas condensates of Gugurtli and Naip deposits at the temperatures between 50 and 200°C and pressures between 1-500 bar is investigated. Empirical relations are obtained reflecting all the experimental data with good accuracy within the stated range of temperatures and pressures.

STORAGE

REFER ALSO TO CITATION(S) 36855

36873 **User's manual of property data in graphic format.** Mann, D. (ed.). Boulder, CO; National Bureau of Standards (1977). 315p. .

The materials and fluid property data presented are limited to cryogenic temperatures. Data are presented for materials used as primary containment materials, Al alloys (3003, 5083, 6061), Invar (Fe—36Ni), Ni steels (2¼, 3.5, 5, 9% Ni), and stainless steels (304, 304L, 310, 316); for the pure fluids CH_4 and N_2, and for mixtures of CH_4 and N_2. The data are presented primarily in graphic form in a loose-leaf binder for convenience of updating and additions.

OIL SHALES AND TAR SANDS

DRILLING, FRACTURING, AND MINING

36874 (CONF-770440—, pp 357-367) **Dynamic fracture and fragmentation of oil shale.** Murri, W.J.; Curran, D.R.; Shockey, D.A.; Seaman, L.; Tokheim, R.E.; McHugh, S.L. (Stanford Research Inst., Menlo Park, CA). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

A key aspect in development of a method for in situ retorting of oil shale is fracturing the shale to produce the necessary permeability. In this paper, we describe work in progress to develop a computational fracture model for oil shale for use in simulating explosively produced fracture and fragmentation. The model assumes the existence in the oil shale of a population of weak spots in a range of sizes. When traversed by a stress pulse, the larger of the weak spots become cracks, which propagate until either the stress pulse vanishes or until they coalesce with neighboring cracks. In the latter case fragments may form. A constitutive model for oil shale was developed from Lagrangian analysis of stress-time histories obtained in plate-impact experiments and from dynamic yield strength data. This constitutive model together with the fracture and fragmentation parameters will be used in a wave propagation code to simulate small-scale bore-hole experiments in oil shale. In these experiments explosive is placed in a hole drilled along the axis of a cylinder of oil shale. The cylinder is placed in a vessel under confining pressure to simulate the overburden, and the explosive detonated. The cylinder is then sectioned at several places and the observed damage is quantified.

36875 (CONF-770440—, pp 468-492) **Bureau of Mines oil shale R and D program.** Utter, S. (Bureau of Mines, Denver). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

Since 1974, we have been conducting an R and D program to advance oil shale mining technology. This is part of the Bureau's overall energy extraction research and development program. Our objectives are to develop, test, demonstrate and transfer to industry, improved methods and equipment needed for extracting the large tonnages of oil shale and/or shale oil required for a viable synthetic liquid fuels industry. Equally large tonnages of waste shale residue from the retorting operations must be handled in an environmentally sound manner. Two major phases of the program are Baseline Studies and Development and Demonstration. Four of the Baseline Studies have been recently completed and the reports published. These describe the technical and economic feasibility of underground, open pit and modified in situ extraction methods; and the physical and chemical composition of retorted shale for design of full-scale disposal plans. Several promising concepts have been developed for large-scale, low-cost, underground mining of the thick, deep, oil shale deposits in the central Piceance Creek Basin of Colorado. The next phase of the program is to test the validity of these concepts under actual mining conditions. Core holes have been drilled and a site selected for the testing and demonstration of these methods. Construction of a 10-ft OD bored shaft is under way. This 2,400-ft deep shaft will provide access to the lower or Saline Zone where bulk samples will be mined and geotechnical and hydrology tests conducted. This shaft may be used as a ventilation shaft for a larger experimental mining operation proposed for a later date.

OIL PRODUCTION, RECOVERY, AND REFINING

REFER ALSO TO CITATION(S) 36875

36876 (CONF-770440—, pp 102-113) **Current developments in oil shale processing.** Prien, C.H. (Denver Research Inst.). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

Presently available technology for producing shale oil from western U.S. oil shale deposits includes both surface retorting and in situ processing. Five surface processes, viz TOSCO II, Paraho, Union B, Superior, Lurgi, have been operated at either the pilot

plant or semi-works level. Increasing emphasis is being placed on both true in situ and modified in situ methods, because of their apparent lesser environmental impacts and potentially lower costs. Developments are occurring on both government lease sites and private lands. The high investment costs involved are a formidable barrier to early creation of a U.S. shale oil industry.

IN SITU METHODS, TRUE AND MODIFIED

36877 (CONF-770440—, pp 138-148) **In situ oil shale fracturing experiment: some preliminary results.** Stevens, A.L. (Sandia Labs., Albuquerque, NM); Tyler, L.D.; Long, A. 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

A major factor in the development of true in situ oil shale processing technology is the development of techniques for adequately rubblizing the bed for subsequent retorting. This requires both fracturing the oil shale bed, with appropriate particle size distribution, as well as introducing and distributing void space within the fractured zone to provide sufficient permeability for the in-place processing. A series of field experiments has been jointly undertaken by the ERDA Laramie Energy Research Center and Sandia Laboratories aimed at developing techniques for producing and characterizing the extent and degree of fracturing in an oil shale formation. The first field experiment in this series has essentially been completed. Descriptions are given of the experiment and the instrumentation and analysis techniques for assessing the degree and extent of fracture and permeability produced. Preliminary results of the experiment indicate that extensive fracturing has been achieved but the resulting permeability is low.

36878 (CONF-770440—, pp 114-125) **Effect of combined modified in situ/above ground processing of oil shale.** McCarthy, H.E. (Oil Shale Industry Development Co., Bakersfield, CA). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

The effect of combining the modified in situ process with an aboveground retorting of the mined shale is discussed. A parametric study showing the effect of mining different zones and the overall resource recovery is given. Using published numbers, an attempt is made to show the advantages of the combined processes.

36879 (CONF-770440—, pp 126-137) **Some results from the Site 9 in situ oil shale experiment at Rock Springs, Wyoming.** Long, A. Jr.; Merriam, N.W.; Mones, C.E.; Romanowski, L.J. (Energy Research and Development Administration, Laramie, WY). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

This paper presents results of the first 150 days of in situ retorting of oil shale at site 9 near Rock Springs, Wyo. A 70-foot (21.4 m) square of 21.3 gpt (89 liters pmt) oil shale in the Green River Formation was explosively fractured. Following the ignition on April 5, 1976, the combustion front was monitored with a computer based data acquisition system which reported conditions hourly. Nitrogen balances showed average gas recovery of 93 percent with an average oxygen utilization of 65 percent. Material balance calculations indicated 3,260 tons (2,964 m tons) representing 21 percent of the oil shale was retorted. Oil migration beyond the recovery area was evidenced and only 2,483 gallons (9,300 liters) of shale oil was recovered. Low Btu gas produced had a total calorific value of 1,515 million Btu (382 million Kcal). Environmental studies of effects on air, ground surface, and ground water were conducted. A complete evaluation of the test will be made after core samples are taken.

36880 (CONF-770440—, pp 493-504) **Modified in-situ oil shale technology at the Lawrence Livermore Laboratory: experimental results and present status.** Lewis, A.E.; Rothman, A.J. (Univ. of California, Livermore). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

An experimental effort is in progress to obtain a comprehensive understanding of the oil shale retorting process. Recent results have increased understanding of the mechanism of yield loss, the decomposition of carbonate minerals, and the reaction of char with O_2 and CO_2. A computer model has been compared successfully with retort experiments and is proving useful in optimizing the process and in designing further experiments.

36881 (CONF-770440—, pp 505-515) **Evaluation of in-situ recovery of tar sands.** Arscott, R.L.; David, A. (Gulf Research and Development Co., Pittsburgh). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

Several field tests of in situ recovery of tar and heavy oil expose the difficulty of achieving an acceptable economic process. The technical problems encountered in achieving successful projects are: adequate communication between wells, mobilization of the tar, and maintenance of production wells. If currently available technology for the recovery of tar sand is to compete economically with world prices for other resources, only the highly saturated, thick tar zones can be considered. The Alberta and Venezuelan resources qualify, but much of the U.S. resource is of questionable value.

36882 (FE—2346-22) **Energy from in situ processing of Antrim oil shale. Monthly technical progress report for February 1978.** Humphrey, J.P. (Dow Chemical Co., Midland, Mich. (USA). Hydrocarbons and Energy Research Dept.). 16 Mar 1978. Contract EX-76-C-01-2346. 18p. (DOW/SRPR—22). Dep. NTIS, PC A02/MF A01.

The following are reported for this month: resource inventory; lithological, geophysical and geochemical characterization; in-situ fracturing and assessment; and in-situ extraction trials. (DLC)

36883 (LA-UR—78-616) **Statistical theory of fragmentation.** Dienes, J.K. (Los Alamos Scientific Lab., N.Mex. (USA)). 1978. Contract W-7405-ENG-36. 6p. (CONF-780509—4). Dep. NTIS, PC A02/MF A01.

From 19. symposium on rock mechanics; Lake Tahoe, NV, USA (1 May 1978).

An initially exponential distribution of cracks that grow in size and nucleate additional cracks is analyzed, leading to an expression for the statistical distribution of cracks as a function of time in closed form. The results are used to derive a reduced modulus for the cracked material. An approach to three-dimensional calculations of fragmentation is also discussed.

36884 **Multi-stage method of operating an in situ oil shale retort.** Bartel, W.J.; Burton, R.S. III. (to Occidental Oil Shale, Inc.). US Patent 4,072,350. 7 Feb 1978. Filed date 27 Jan 1977. 12p.

A method of processing oil shale is described in which an in situ oil shale retort comprising an elongated cavity containing a fragmented permeable mass of formation particles containing oil shale is formed in a subterranean formation containing oil shale to recover liquid and gaseous products. Access to the cavity is by a drift or conduit at each end of the cavity and through a drift at an intermediate position. A processing zone is established in the fragmented mass at one end of the cavity and processing gas is introduced at that end of the retort and heating of the fragmented mass of formation particles is conducted from that end towards the other end. Initially, off gas is withdrawn at the intermediate drift. When the processing zone passes the intermediate drift, processing gas is introduced through the intermediate drift and off gas including gaseous products is withdrawn by way of the drift at the other end. As the processing zone passes the intermediate drift, processing gas is introduced at one end and off gas is withdrawn from the other end of the retort.

SURFACE METHODS

36885 (CONF-770440—, pp 516-527) **Effects of particle size on retorting oil shale in a controlled-state retort.** Bartke, T.C.; Duvall, J.J. (Energy Research and Development Administration, Laramie, WY). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

Experiments were conducted in a controlled-state retort at the Laramie Energy Research Center to determine the effect of oil shale particle size on the boiling range distribution of shale oil and unretorted bitumen. This study also provided insight about the movement of shale oil over unretorted oil shale. Oil shale, in the particle size ranges $^3/_{64}$- to $^3/_8$-inches, $^1/_8$- to $^1/_2$-inches, and $^3/_8$- to $^3/_4$-inches, was retorted in interrupted and completed experiments. All experiments were conducted with nitrogen as the carrier gas to avoid combustion. Data included the amounts of shale oil and unretorted bitumen recovered, boiling range distribution of the shale oils and bitumens, analyses of the shales, and effluent gas compositions. Analysis of the data showed that the smallest oil shale particles (1) retained more shale oil on their surface, (2) allowed shale oil to emerge from the oil shale at a lower temperature, (3) yielded a lower boiling crude shale oil, and (4) retained more carbon residue on the retorted shale.

36886 (TID—27954) **Analysis of water requirements for oil shale processing by surface retorting. Final report.** (Eyring Research Inst., Provo, Utah (USA); Sutron Corp., Arlington, Va. (USA)). 5 Aug 1976. Contract EX-76-X-01-0022. 59p. Dep. NTIS, PC A04/MF A01.

The major conclusions of the study are Zero-water-discharge oil shale operations can be designed. Brackish water, which is readily available in the shale areas, can be used for all the water

needs related to the shale oil process except for vegetation. The readily available brackish water is too saline to be used for agriculture, and thus its use for production of shale oil need not be considered competetive to agricultural water needs. There is ample water in the Piseance Basin to permit the shale oil present to be processed. However, water will probably be a limiting factor in determining the rate at which oil shale lands can be worked. Economic factors will be the overall controlling parameter. If water is to be conserved, the retort itself is not the most significant place to look. Conservation of water used for spent shale disposal and vegetation will provide more immediate and significant (economically) savings. A trade-off exists between capital costs and water economics that will shift enough with future price estimates that an optimal water usage point cannot be adequately addressed without predicting the future economics of oil and water together.

REFINING

36887 Denitrogenation of syncrude. Smith, R.H. (to Atlantic Richfield co.). US Patent 4,071,435. 31 Jan 1978. Filed date 6 Jun 1977. 4p.

A method is described for reducing the nitrogen content of a syncrude feed obtained from at least one of oil shale, tar sands, and coal wherein the syncrude is mixed with an extractant-catalyst which is effective for extracting nitrogen materials from the syncrude feed and also effective as a hydocracking catalyst for the syncrude feed. The mixing helps form a first phase composed of a first low nitrogen syncrude product and a second phase composed of the extractant-catalyst and high nitrogen syncrude feed, separating the first and second phases from one another, and hydrocracking the second phase to produce a second low nitrogen syncrude product.

PROPERTIES AND COMPOSITION

REFER ALSO TO CITATION(S) 36882

36888 (CONF-770440—, pp 149-157) **Eastern oil shale.** Humphrey, J.P. (Dow Chemical Co., Midland, MI); Wise, R.L. 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

Oil shale occurs throughout much of the United States. The best known is the Eocene Green River formation of Colorado, Wyoming and Utah. The Green River oil shales are not our only national oil shale option. Some oil shales exist in Montana, California and Alaska. Of great interest are the very extensive oil shale deposits existing in the Eastern and Midwestern parts of the United States. These black Devonian shales contain some organic matter deposited as dead vegetation along with muds and silts in a large marine sea. Like all oil shales when heated, the kerogen breaks down into oils and gases, which can be recovered for fuel or refined for petrochemical feed stocks. Devonian oil shale is quite different from its Western counterpart. They typically yield upon retorting ten or less gallons of oil per ton, and produce more light hydrocarbon gases. Also, the rock matrix is mainly Illite, an iron, aluminum, potassium, magnesium and silicon clay mineral with very little carbonate. Several Devonian shale deposits in the U.S. were considered for experimentation in the early work by Dow Research, but because of its convenient location and because of fuel and hydrocarbon needs in Michigan, the Antrim was selected for a rather extensive laboratory and field experimental program. This effort was directed, as it is today, toward in situ (in place) recovery using partial combustion with air to produce oil and a low Btu gas. Prior to the seventies, there was little incentive to accelerate the development of these lean shales, but this is not the case today. Because of the dwindling U.S. oil and gas supplies, because of Eastern oil shale being located under the industrial center of the U.S., and because of its unique character, a plan for its accelerated development is being implemented under an ERDA-sponsored program.

36889 (CONF-770440—, pp 381-391e) **Mechanical properties of oil shale of importance to in-situ rubblization.** Schuler, K.W.; Schmidt, R.A. (Sandia Labs., Albuquerque, NM). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

Current proposals for true in situ processing of oil shale employ deeply buried explosive charges to produce the desired rubblization. At short times after the explosion, the dynamic behavior of the material is of interest and can be studied in shockwave experiments. At intermediate times the divergence of the flow field requires a multidimensional specification of the material behavior which appears to be best determined from triaxial test data. At late times the possible formation of tensile stresses requires knowledge of the fracture mechanics and tensile behavior of the shale. This report presents a summary of techniques and results of triaxial compression, extension and fracture toughness tests on two grades of oil shale. The results indicate that oil shale differs significantly from most rocks and suggest that models originally developed for composite materials may be appropriate for describing the mechanical behavior of oil shale.

NUCLEAR FUELS

RESERVES

REFER ALSO TO CITATION(S) 37516, 38331

36890 United States uranium position. Boyd, J. pp 143-151 of Uranium supply and demand. London; Mining Journal Books (1977).

From 2. symposium on uranium supply and demand; London, UK (22 Jun 1977).

See CONF-7706120—.

It is concluded that the time between the decision to mine and equip a given unit of uranium reserves and the time that it will be available to a power plant is 10 to 15 years. The time in which that uranium is in residence in a LWR before the derived plutonium and ^{239}U are recaptured for further use is of the order of 10 or more years. It will take several years to reverse the present prohibition on recycling and reactivate or build the required plants. It appears that, unless drastic action is taken, there will not be sufficient uranium forthcoming to sustain a nuclear industry based upon LWRs. As a consequence, it is imperative that we extend our uranium resources and reserves by developing and commercializing some sort of advanced converter as soon as possible. The present state of the art would indicate that this will have to be the Liquid Metal Breeder Reactor or the advanced system (Candu) adopted by the Canadians.

36891 Uranium. Ramford, L.C. pp 335-344 of Australian Mineral Industry. 1975 Review. Ward, J. (ed.). Canberra, Australia; Australian Government Publishing Service (1977).

Australian production, reserves, consumption, trade and exploration of uranium are covered in the review. A summary of prices and current developments around the world is also included.

36892 Rare accessory uraninite in a Sierran granite. Snetsinger, K.G. (NASA-Ames Research Center, Moffett Field, CA); Polkowski, G. *Am. Mineral.;* **62**: No. 5/6, 587-588(1977).

Uraninite occurs as a minor accessory constituent in a Sierran granite. The mineral is rare; one grain was found in a single thin-section, and no further uraninite has been noted in heavy mineral concentrates from other rocks of the local area. Electron and ion microprobe analysis gives UO_2 85.4, ThO_2 6.8, PbO_2 1.8, Y_2O_3 1.7, Nd_2O_3 0.6, and H_2O 3.0, sum 99.3 weight percent. UO_3 could not be analyzed directly, but approximate cell-edge data suggest $UO_{2.15}$ as a composition. Because additional possibly uranium-bearing minerals (e.g., zircon, apatite, allanite) are present in the rock, it seems unusual that a discrete uranium-rich mineral should coexist with them. The U—Pb age calculated for the uraninite is, however, not greatly different from the K—Ar age of the unit in which it occurs; it therefore is suggested that the mineral is primary and not reworked from a preexisting rock.

EXPLORATION

REFER ALSO TO CITATION(S) 36911

36893 (CONF-581102—1) **Ground water conditions and the relation to uranium deposits in the Gas Hills area, Fremont and Natrona Counties, Wyoming.** Marks, L.Y. (Department of Energy, Grand Junction, Colo. (USA). Grand Junction Office). Mar 1978. Contract EY-76-C-13-1658. 13p. (TM—197). Dep. NTIS, PC A02/MF A01.

From Meeting of the Geological Society of America; St. Louis, MO, USA (8 Nov 1958).

As ground water apparently leaches, transports, and deposits uranium in the Gas Hills area, central Wyoming, it is important to understand its distribution, movement, and relation to geology and ore bodies. Water table maps were prepared of the Wind River Basin; the most detailed work was in the Gas Hills area. The water table in the Gas Hills area slopes downward to the northwest, ranges in depth from near the ground surface to more than 200 feet, and has seasonal fluctuation of about five feet. Perched water tables and artesian conditions occur locally. The oxidized-unoxidized rock contact is probably roughly parallel to the water table, and averages about 25 feet above it; although locally the two surfaces are considerably farther apart and the oxidized-unoxidized contact may be

below the water table. In many places the gradient of the water table changes near the contact between rocks of different permeability. It is conformable with the structure at some anticlines and its gradient changes abruptly near some faults. Most above-normal concentrations of uranium occur at local water table depressions or at water table terraces where the gradient of the water table flattens. At these places, the uraniferous ground water is slowed and is in contact with the reducing agents in the rocks for a relatively long time. This may allow reduction of soluble transported uranium (U^{+6}) to insoluble U^{+4}) so that uranium is precipitated.

36894 (GJBX—55(78)) **Uranium hydrogeochemical and stream sediment reconnaissance of the Ekalaka NTMS Quadrangle, Montana.** Chaney, D.S.; Bolivar, S.L. (Los Alamos Scientific Lab., N.Mex. (USA)). Mar 1978. Contract W-7405-ENG-36. 76p. (LA—7069-MS). Dep. NTIS, MF A01.

Portions of document are illegible.

The Los Alamos Scientific Laboratory (LASL) conducted a Hydrogeochemical and Stream Sediment Reconnaissance in the Ekalaka National Topographic Map Series Quadrangle, Montana. A total of 710 water and 851 sediment samples were collected from 1347 locations at a nominal density of 1 location per 10 km². All water samples were analyzed by fluorometry and those with greater than 10 ppB uranium were reanalyzed by delayed-neutron counting. Sediment samples were analyzed by delayed-neutron counting. Standard field and analytical procedures developed by the LASL were followed. A value nominally twice the standard deviation above the mean was selected as the "anomaly threshold." By this criterion, 27 waters (19 wells, 5 springs, and 3 surface waters) and 33 sediments (26 dry streams, 4 wet streams, 2 wet springs, and 1 dry artificial pond) contained anomalously high uranium concentrations. The study delineated most known uranium occurrences. In addition, several areas were identified that appear of interest for further investigation. These are: (a) in the Belle Fourche shale formation and alluvium along Thompson Creek near the Black Hills uplift; (b) in the vicinity of Bay Horse/Moorhead in the Powder River basin; and (c) in the Long Pine Hills area in the Williston basin, although this area has been prospected before. The principal hosts for the known deposits are arkosic sandstones (Fort Union or associated formations) and lignite beds.

36895 (GJBX—57(78)) **Uranium hydrogeochemical and stream sediment reconnaissance data release for the Montana portion of the Hamilton, Montana/Idaho, NTMS quadrangle.** Aamodt, P.L. (Los Alamos Scientific Lab., N.Mex. (USA)). Mar 1978. Contract W-7405-ENG-36. 46p. (LA—7178-MS). NTIS, MF A01.

Portions of document are illegible.

During the fall of 1976, water and/or sediment samples were collected from 745 locations within the Hamilton NTMS quadrangle. An additional 21 locations were sampled in the spring of 1977. All sample locations were selected using guidelines developed by the LASL (Sharp, 1977). Due to snow conditions, coverage in the high mountain areas was sparse, but additional locations were sampled along the base of the mountains to maintain a nominal density of at least one location every 10 km². A listing is given of all field and analytical data for the water and sediment samples. (DLC)

36896 (LA—7054-M) **Field procedures for the uranium hydrogeochemical and stream sediment reconnaissance as used by the Los Alamos Scientific Laboratory.** Sharp, R.R. Jr.; Aamodt, P.L. (Los Alamos Scientific Lab., N.Mex. (USA)). Apr 1978. Contract W-7405-ENG-36. 67p. (GJBX—68(78)). Dep. NTIS, PC A04/MF A01.

This manual of field procedures is prepared to aid personnel involved in the field sampling of natural waters and waterborne sediment for the Los Alamos Scientific Laboratory (LASL) as part of the US Department of Energy (DOE) Hydrogeochemical and Stream Sediment Reconnaissance (HSSR) of the National Uranium Resource Evaluation (NURE) program. It presents the procedural guidelines to be followed by all contractors, contractor employees, and others who collect, treat, or otherwise handle samples taken for the LASL as part of the HSSR program. Part I relates to all sampling in the conterminous states of the US for which the LASL is responsible to the DOE for carrying out the HSSR work. Part II describes procedures to be followed for HSSR work, using helicopter support, in the state of Alaska. The objective of the manual is to insure that consistent techniques are used throughout the survey. If any procedure is unclear or cannot be followed, telephone collect to Group G-5, LASL, (505) 667-7590, for further instructions. No variations in the specific procedures should be made without prior approval of the LASL.

36897 (UCID—17699) **Lawrence Livermore Laboratory hydrogeochemical and stream sediment reconnaissance. Raw data report: Winnemucca Dry Lake Basin orientation study, Lovelock and Reno 1° x 2° NTMS area, Nevada.** Puchlik, K.P.; Holder, B.E.; Smith, C.F. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jan 1978. Contract W-7405-ENG-48. 37p. (GJBX—65(78)). NTIS, PC E02/MF E02.

Portions of document are illegible.

This report presents the results of the Winnemucca Dry Lake Basin, Nevada, orientation study in the Lovelock and Reno 1° x 2° quadrangles of the National Topographic Map Series (NTMS). Wet, dry, and playa sediment samples were collected throughout the 597 km² semi-arid, closed basin. Water samples were collected at the few available streams and springs. In addition to neutron activation analysis for uranium and 15 to 20 trace elements on all samples, field and laboratory measurements were made on water samples. Analytical data and field measurements are presented in tabular hardcopy and fiche format. Eight full-size overlays for use with the Lovelock and Reno NTMS 1:250,000 quadrangles are included. Water sample site locations, water sample uranium concentration, sediment sample site locations, and sediment sample total uranium concentration are shown on the separate overlays. A general description of the area and the rock type distribution is presented. Some of the data in this report have been issued previously in "Preliminary Report on the Winnemucca Dry Lake Basin Pilot Study," GJBX-41(76), August 1976.

36898 **Uranium exploration techniques: their applicability and limitations.** Dahlkamp, F.J. pp 130-141 of Uranium supply and demand. London; Mining Journal Books (1977).

From 2. symposium on uranium supply and demand; London, UK (22 Jun 1977).

See CONF-7706120—.

This paper deals with the practical application and limitations of well-known techniques of uranium exploration, by means of selected examples. Section headings are: necessary basis for exploration; applicability and limitations of selected techniques (radiometry/spectrometry, emanometry, non-geophysical techniques, non-radiometric geophysical techniques, methods of creating exposures); conclusions and evaluation of the various techniques.

36899 **Changing picture of uranium exploration.** Duval, B.C. pp 110-129 of Uranium supply and demand. London; Mining Journal Books (1977).

From 2. symposium on uranium supply and demand; London, UK (22 Jun 1977).

See CONF-7706120—.

The purposes of this paper are: firstly, to analyze the factors determining exploration strategies, special emphasis being given to the task of defining exploration targets as dictated by projected demand, and to discussing the chances of making new discoveries necessary to meet this challenge; secondly, to delineate the main trends apparent in exploration activities across the free world and to interpret them in the light of this analysis; and, thirdly, to show how the exploration activities of an independent company like Minatome specifically illustrate these points. The various aspects covered include: natural uranium requirements for nuclear power reactors on line, 1970 to 2025; cumulative natural uranium requirements for the same period; availability of economic reserves; geological aspects; financial and political factors; exploration techniques.

36900 **Purpose function of the acrial gamma spectrometry method (AGSM) in geological investigation system.** Ostrovskii, Eh.Ya. (Ministerstvo Geologii SSR, Moscow). pp 6-29 of Primenenie kodovykh aehrogammaspektrometrov i universal'nykh EhVM pri poiskakh rudnykh mestorozhdenij. Moscow; Ministerstvo geologii SSSR (1976). (In Russian)

The objective function of airborne gamma spectrometric method is defined as a search for geochemically anomalous radioactive objects on the basis of investigating space variations in the intensities of the thorium, uranium and potassium components of radioactive radiation which arise in the near-Earth atmosphere as a result of variations in the contents of radioelements in the upper (30 to 50 cm) layer of the Earth's surface, variable geometrical conditions of measurements and the variable radioactivity of the atmospheric air. Three indications of anomalism are pointed out, viz. correlated changes in the intensity of at least two components with respect to the background totality of their mutually independent values, a low probability of a given combination of the intensities of field components belonging to the background sample and the dominancy, i.e. the rapidity of increase, in the anomaly, of one field component over another. Rational ways of separating the "anomaly-background" system, effectiveness criteria of separation and some questions of the metrology of measurements have been considered.

MINING

REFER ALSO TO CITATION(S) 37006, 37810

36901 **Current Australian uranium position.** Grey, A.J. pp 212-220 of Uranium supply and demand. London; Mining Journal Books (1977).

From 2. symposium on uranium supply and demand; London, UK (22 Jun 1977).

See CONF-7706120—.

The present situation of uranium mining in Australia is discussed from the economic, technical, environmental and political points of view. The projected production capacity and its importance in relation to world uranium supplies is outlined. The Australian safeguards policy is stated.

36902 (CONF-770440—, pp 740-751) **Effect of sodium silicate on leaching uranium ores with hydrogen peroxide.** Lawes, B.C. (E.I. Du Pont de Nemours and Co., Inc., Wilmington, DE). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

Hydrogen peroxide has been widely used as an oxidant for in-place solution mining of low-grade uranium ores with ammonium bicarbonate. Recent laboratory column leaching experiments have shown that hydrogen peroxide, under accelerated flow conditions at least, appears to contribute to a partial loss of permeability, which varies with different ores. However, when small quantities of sodium silicate are added to the leach, the loss of permeability is largely prevented, or even reversed. With some ores, the silicate also helped to stabilize hydrogen peroxide against decomposition.

36903 (CONF-770440—, pp 752-763) **Economic evaluation of in situ extraction of uranium.** Chase, C.K.; Winters, H.J.; Bhappu, R.B. (Mountain States Research and Development, Cucson, AZ). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

In situ extraction of uranium using the "bore hole mining" technology is no longer an experimental technique but a viable process whose operational and economic parameters are well established. Such a technique is economically and environmentally attractive in recovering uranium values especially from deeper lower grade and limited ore deposits. Like any conventional extraction process, the selection of this newly developed process for a given low grade uranium deposit is solely based upon economic evaluation of the project. The physical and chemical characteristics of the ore deposit, the grade-thickness (GT) product, expected recovery under in situ environment, the capital and operating cost, and the prevailing price of U_3O_8 all play an important role in the overall economics of the project. In this paper, efforts have been made to provide a case history of a feasibility study concerning the in situ extraction of uranium from a low grade deposit using the "bore hole mining" technique.

36904 **Canada's uranium production potential.** Merlin, H.B. pp 189-202 of Uranium supply and demand. London; Mining Journal Books (1977).

From 2. symposium on uranium supply and demand; London, UK (22 Jun 1977).

See CONF-7706120—.

The subject is discussed under the following headings: Ontario operations (Agnew Lake Mines Ltd., Rio Algom Ltd., Denison Mines Ltd., Madawaska Mines Ltd.); Saskatchewan operations (Gulf Minerals Canada Ltd., Eldorado Nuclear Ltd., Amok Ltd., Key Lake); other projects (Brinex-UG, dormant mines); production potential (estimated annual Canadian uranium production, 1976 to 1990); exploration activity (with maps showing: uranium -bearing areas in Canada, airborne gamma-ray spectrometry reconnaissance surveys, geochemical surveys for uranium and other metals). Canada's uranium production potential is expected to grow from the 1976 level of 4,850 tonnes to 12,500 tonnes in 1984. Only about 10% of the output in 1976 was required for the Canadian nuclear program. Domestic needs will grow to about 16% of the expected production in 1980.

36905 **Ranstad project and other Swedish projects and possibilities.** Carlsson, O. pp 203-211 of Uranium supply and demand. London; Mining Journal Books (1977).

From 2. symposium on uranium supply and demand; London, UK (22 Jun 1977).

See CONF-7706120—.

Swedish uranium deposits are described and the present mining and development program is outlined. It is concluded that the only Swedish uranium production possible in the early 1980s will be about 200 tonne/year uranium at Ransted from a production/research plant. The iron ore company LKAB believes there is a future for the exploitation of Swedish shale, which will result in the production of a broad spectrum of minerals of economic interest.

36906 **Factors affecting mining costs.** Lowell, A.F. pp 221-228 of Uranium supply and demand. London; Mining Journal Books (1977).

From 2. symposium on uranium supply and demand; London, UK (22 Jun 1977).

See CONF-7706120—.

The subject is discussed under the following headings: investment decision-making, unit cost factors (declining ore grade, low-price contracts, ore grade/output relationship, above average cost increases). Economic, environmental, sociological and political aspects are considered.

36907 **Australia and uranium.** Anon. Canberra, Australia; Australian Government Publishing Service (1977). 11p.

A brief justification of the Australian Government's decision to mine and export Australian uranium is presented along with a description of the Alligator River Region in the Northern Territory where the major mines are to be located. Aboriginal interests and welfare in the region, the proposed Kakadu National Park and the economic benefits resulting from uranium development are also briefly covered.

FEED PROCESSING

REFER ALSO TO CITATION(S) 37006

36908 (BM-RI—8282) **Design requirements for uranium ion exchange from acidic solutions in a fluidized system.** Traut, D.E.; Nichols, I.L.; Seidel, D.C. (Bureau of Mines, Salt Lake City, Utah (USA). Salt Lake City Metallurgy Research Center). 1974. 34p. Dep. NTIS, PC A03/MF A01.

A fluidized, countercurrent ion-exchange system was developed, operated, and evaluated by the Bureau of Mines in support of its objective to help assure an adequate uranium supply for future national needs. The system consisted of integrated multiple-compartment absorption and elution columns in which the solution flows are continuous, except for short periods when resin increments are withdrawn. The exchange of uranyl sulfate between a simulated acid-leach-uranium solution and a strong-base, ion-exchange resin was studied, together with subsequent elution using an acidified sodium chloride solution. The effects of the number of compartments, compartment height, amount of resin withdrawal, solution flow rate, and column diameter were investigated. Also examined were the kinetic and equilibrium relationships for the absorption and elution steps. The experimental data indicate a strong interdependence between variables. Solution retention time appears to be a major limiting variable in the absorption process, while resin residence time is the determining factor in the elution process. The columns system was efficient over a range of conditions, but close control was needed for optimum operation.

36909 (IAEA-R—1470-F) **Microbial oxidation and reduction of inorganic sulfur compounds in relation to the development and control of microorganisms active in leaching operations. Part of a coordinated programme on bacterial leaching of uranium ores. Final report for the period 1 April 1974—31 October 1976.** Tuovinen, O.H. (International Atomic Energy Agency, Vienna (Austria)). Jan 1977. 6p. Dep. NTIS (US Sales Only), PC A02/MF A01.

The project considers the use of Thiobacillus ferroxidans type bacteria for the leaching of metals from ores. The various ways by which Thiobacillus ferroxidans utilizes inorganic sulfur compounds for oxidation, energy, growth, and synthesis of cellular material were studied. The report briefly describes the scope and background of the project, and a list of publications describing experimental methods and research materials used is given. Unpublished work commenced during the Research Contract includes three major projects: (1) Transition of Thiobacillus ferroxidans from heterotrophic growth on fucose to autotropic growth on ferrous-iron; (2) development of a method to determine the ATP-content of bacteria attached to ore particles; (3) microbiological and chemical interactions of inorganic sulfur compounds. These three projects are summarized briefly.

36910 (IEA—453) **Optimization of the caldasite processing conditions by alkaline melting.** Brown, A.E.P. (Instituto de Energia Atomica, Sao Paulo (Brazil). Divisao de Engenharia Quimica). Dec 1976. 20p. (In Portuguese). Dep. NTIS (US Sales Only), PC A03/MF A01.

A study has been done on the economical recovery of the uranium and zirconium values of ores at Pocos de Caldas Plateau in the state of Minas Gerais, Brazil. In a preliminary study, the processing of the ore by alkaline fusion was carried out in a temperature controlled furnace, the variables studied were the time, temperature, and NaOH/ore ratio. The optimization procedure was based on the steepest Ascent Method developed by Box and Wilson, utilizing a complete 2^3 factorial design. Results of data indicated the response

optimum for the process in: time 1.52 +-0.1 hour; temperature 805 +-15°C; NaOH/ore ratio 1.7 ton/ton. Solubilizations higher than 97% ZrO_2 and recuperations nearly of 100% U_3O_8 are obtained at about this point.

36911 (PNL—2593) **Assessment of U.S. domestic capacity for producing reactor-grade thorium dioxide and controlling associated wastes and effluents.** Enderlin, W.I. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Feb 1978. Contract EY-76-C-06-1830. 58p. Dep. NTIS, PC A04/MF A01.

Demand for reactor-grade ThO_2 is likely to increase as a result of the growing interest in the application of the thorium-uranium fuel cycle to nuclear reactors. The wastes and effluents identified with the production of ThO_2 from monazite sand are waste water, tailings, dust, smoke and gas, and radionuclides (primarily, ^{232}Th and ^{226}Ra). There are currently an estimated 1,500 short tons of crude thorium hydroxide byproduct that can be readily converted to reactor-grade ThO_2. The present maximum domestic capacity for producing reactor-grade ThO_2 is about 65 to 100 ton/year. The current domestic capacity for producing reactor-grade ThO_2 is sufficient to sustain a thorium-uranium fuel cycle of up to 11,000 MW(e) without recycling thorium, depending on the mix of reactor types selected. This range can be increased to 28,000 MW(e) by expanding ThO_2 purification capacity to match the current production rate of crude thorium byproduct. Potential constraints identified which may impact the expansion of domestic ThO_2 production are (1) uncertainty in the marketplace, (2) limited available thorium for production of reactor-grade ThO_2, (3) limited production capacity, and (4) mounting public concern over current levels of radioactivity detected at various points in the production process of thorium and uranium products.

36912 **Bacteria now used for leaching local uranium.** Livesey-Goldblatt, E.; Tunley, T.H.; Nagy, I.F. *Met. Miner. Process.;* **1**: No. 1, 7-9, 12-13, 15(Oct 1977).

A strain of thiobacillus ferro-oxidans was cultivated and gradually accustomed to the uranium and manganese concentrations found in leach liquors from extraction of uranium ores in South Africa. Studies of the oxidation of Fe(II) to Fe(III) in leach liquors with added ammonium ion demonstrate that the bacteria is established as a film on glass surfaces and is associated with a deposit of Jarosite [$Mfe_3(SO_4)_2(OH)_6$ where M = NH^+_4 or K^+]. This film, which was also found to grow on plastic, has a greater influence on ferrous ion oxidation than the bacteria in solution. Four pilot plant systems were investigated to determine the most suitable type and to determine if the bacterial film was self maintaining. These four types of plants were: (1) plate and spray unit, (2) rotating discs, (3) trickle flow on plastic rings, and (4) submerged corrugated packing-forced aeration. Pilot plant data indicated that once the film was established, it was stable with no evidence of bacterial loss from the film over a period of two years. The pilot plants were operated under conditions with solutions that were anticipated to come from a uranium leaching operation, and it was demonstrated that although the NH^+_4 concentration of the solutions was lower than that considered ideal, with sufficient aeration, oxidation does take place.

ENRICHMENT

REFER ALSO TO CITATION(S) 37785

36913 (INIS-mf—4045) **South Australia, uranium enrichment. Second interim report of the uranium enrichment committee, February 1976.** (Australian Mineral Development Labs., Frewville). Feb 1976. 75p. Dep. NTIS (US Sales Only), PC A05/MF A01.

The Report sets out the salient data relating to the establishment of a uranium processing centre at Redcliff in South Australia. It is conceived as a major development project for the Commonwealth, the South Australian Government and Australian Industry comprising the refining and enrichment of uranium produced from Australian mines. Using the data currently available in respect of markets, demand, technology and possible financial return from overseas sales, the project could be initiated immediately with hexafluoride production, followed rapidly in stages by enrichment production using the centrifuge process. A conceptual development plan is presented, involving a growth pattern that would be closely synchronised with the mining and production of yellowcake. The proposed development is presented in the form of an eight-and-half-year programme. Costs in this Report are based on 1975 values, unless otherwise stated.

CENTRIFUGATION

36914 **Report of the Uranium Enrichment Technology Evaluation Committee.** *Genshiryoku Iinkai Geppo;* **21**: No. 12, 26-29(Mar 1977). (In Japanese).

The centrifuge method of uranium enrichment is being pushed forward in Japan as a national project. The results of the technology evaluation are described regarding the efforts heretofore, the plan for pilot plant construction, internationally competitive ability, and the schedule after the pilot plant. In conclusion, the basic technology for proceeding to a pilot plant is now mature, and the pilot plant planning by PNC (Power Reactor and Nuclear Fuel Development Corporation) is generally appropriate. The outlook for constructing an internationally competitive practical plant is reasonably good.

LASER EXCITATION

REFER ALSO TO CITATION(S) 38687

36915 (UCRL—50021-76, pp 8.1-8.45) **Laser isotope separation program.** Jun 1977.

In Laser Program annual report, 1976.

The major goal of the LIS program is to develop economic processes for the large-scale enrichment of uranium for LWR fuel. Research on uranium atomic-vapor spectroscopy and on photon dynamics is reported. Development of the SPP-II (selective photoionization pulsed) test-bed facility, copper-vapor lasers, and dye amplifiers is described. 49 figures, 4 tables. (DLC)

FUELS PRODUCTION AND PROPERTIES

REFER ALSO TO CITATION(S) 37012, 37397, 37726

36916 (AERE-R—8603) **Determination of diffusion coefficients of Cs and Ag in pyrocarbon and silicon carbide by post irradiation annealing of coated particle fuels.** Brown, P.E.; Brownsword, M.; Hooper, E.W. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). Sep 1977. 24p. Dep. NTIS (US Sales Only), PC A03/MF A01.

Diffusion coefficients for Cs in methane and in propylene derived coatings of low enriched UO_2 coated particle fuel, have been determined at 1500°C. The results obtained using irradiated coated fuel particles and an annealing and a grinding technique are as follows: methane-derived pyrocarbon: (1) (by annealing) $D = 2 \times 10^{-12}$ cm^2 sec^{-1}; (2) (by grinding) $D = 1 \times 10^{-12}$ cm^2 sec^{-1}; propylene-derived pyrocarbon: (1) (by annealing) $D = 5 \times 10^{-12}$ cm^2 sec^{-1}; (2) (by grinding) $D = 3 \times 10^{-12}$ cm^2 sec^{-1}. During the course of this work it was found that pyrocarbon afforded no delay at 1500°C to Ag release from the coated fuel particle, but there was some delay when silicon carbide was incorporated in the coating layers.

36917 (AIAU—77504) **Automatic preparation of irradiated nuclear fuel solution samples for analytical purposes.** Forster, H.P.; Bobleter, O. (Atominstitut der Oesterreichischen Hochschulen, Vienna). Aug 1977. 7p. (In German). from Atominstitut der Oesterreichischen Universitaeten, Vienna.

Two apparatuses are described for the automatic dilution and evaporation of nuclear fuel solutions. By this means it is possible to carry out the preparation of samples automatically: for example, the transformation of the solution from the nitrate into the chloride form. A measured volume of the solution thus prepared can then be applied automatically for the analytical procedure.

36918 **Influence of irradiation temperature, burnup, and fuel composition on gas pressure (Xe, Kr, CO, CO_2) in coated particle fuels.** Horsley, G.W. (United Kingdom Atomic Energy Authority, Harwell, Eng.); Weldrick, G.J.; Turnbull, J.A.; Shipp, R. *J. Am. Ceram. Soc.;* **59**: No. 1-2, 1-4(1976).

Relations were derived from gas analyses of irradiated PyC-coated UO_2 fuel particles that enable the quantity of permanent rare gas (Xe + Kr) released within the particle to be predicted from known conditions of irradiation temperature, time, and burnup. The experimentally determined influence of fissions in uranium and plutonium isotopes on the growth of intraparticle CO + CO_2 pressure is discussed and its elimination by an appropriate getter is described.

36919 **Technique for differentiating between open and closed pores on a microscopic scale.** LaValle, D.E.; Costanzo, D.A.; Lackey, W.J.; Sease, J.D. (Oak Ridge National Lab., TN). *J. Am. Ceram. Soc.;* **59**: No. 1-2, 80-81(1976).

The technique involves evacuation of the sample, impregnation of the open pores with nickel carbonyl gas, decomposition of the gas to deposit Ni on the surface of the open pores, and ceramographic observation of the deposited Ni. In this manner, pores connected to the surface of the sample can be distinguished from closed pores since only the open pores will contain Ni. The technique was used in characterizing the porous surface layer of pyrolytic carbon coatings deposited on nuclear fuel microspheres.

SPENT FUELS REPROCESSING

REFER ALSO TO CITATION(S) 36949, 36952, 36979, 37017, 37523, 37765

36920 (GA-A—14878) **HTGR Fuel Recycle Development Program. Quarterly progress report for the period ending February 28, 1978.** (General Atomic Co., San Diego, Calif. (USA)). Mar 1978. Contract EY-76-C-03-0167-053. 265p. Dep. NTIS, PC A12/MF A01.

This publication continues the quarterly series presenting results of work performed under the National HTGR Fuel Recycle Development Program (also known as the Thorium Utilization Program) at General Atomic Company. Results of work on this program prior to June 1974 were included in a quarterly series on the HTGR Base Program. The work reported includes the development of unit processes and equipment for reprocessing of High-Temperature Gas-Cooled Reactor (HTGR) fuel, the design and development of an integrated pilot line to demonstrate the head end of HTGR reprocessing using unirradiated fuel materials, and design work in support of Hot Engineering Tests (HET). Work is also described on trade-off studies concerning the required design of facilities and equipment for the large-scale recycle of HTGR fuels in order to guide the development activities for HTGR fuel recycle.

36921 (JAERI-M—7060) **Feasibility study for removal of SiC coating in HTGR-type fuel by F_2-fluorination.** Maeda, M.; Yagi, E. (Japan Atomic Energy Research Inst., Tokyo). Apr 1977. 18p. Dep. NTIS (US Sales Only), PC A03r/MF A01.

A decladding process only by the gasification reaction, is proposed for the TRISO-type particle fuel through fluorination experiments of SiC and PyC. The process may be adapted to the aqueous separation processes such as Thorex or Purex by framing a "Burn-Fluorination-Reburn-Leach" flowsheet. Feasibility of the proposed flowsheet was confirmed by a boat experiment with unirradiated coated particle. By both experiment and calculation, optimization of the fluorination step is shown to be the key problem for minimum kernel loss.

36922 (BNWL-tr—298) **Catalytic reduction of oxygen and nitrogen oxides with hydrogen in the offgas of reprocessing plants: laboratory experiments on the properties of the catalyst.** Ammon, R.V.; Strauch, K.; Weinlander, W.; Wurster, W. (Kernforschungszentrum Karlsruhe (Germany, F.R.)). Mar 1978. Translation of KFK—2437, May 1977. 46p. Dep. NTIS, PC A03/MF A01.

The activity and selectivity of 13 commercial noble metal catalysts (Pd, Pt, Ru or their mixtures in finely divided form on Al_2O_3 support) towards reduction of O_2 and NO with H_2 were tested. In addition, the behavior of some selected catalysts with respect to overheating and to poisoning by organic phosphate (tributyl phosphate) and iodine was tested. It was found that the Ru catalysts are more suitable than Pt and Pd catalysts for use in cleaning the offgas of reprocessing plants, even though their activity is lower. The main reasons are the higher selectivity of Ru relative to formation of N_2 (less formation of NH_3) and the lower sensitivity towards poisoning. It can therefore be expected that Ru catalysts will permit longer service lives in such offgas systems.

36923 (GERHTR—182) **VENUS: cold prototype installation of the head-end of the reprocessing of HTR fuel elements. Activity report, 1 July 1976—31 December 1976.** Boehnert, R.; Walter, C. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Chemische Technologie; Nuklear-Chemie und -Metallurgie G.m.b.H. (NUKEM), Hanau (Germany, F.R.)). Feb 1977. Translation of KFA-ICT-IB—411/77. 65p. Dep. NTIS, PC A04/MF A01.

Work performed under United States—German High Temperature Reactor Research Exchange Program.

The purpose of the VENUS Project is advance planning for the construction of a cold prototype system to incinerate HTR fuel element graphite. The Venus Project is organized into four phases between advance planning and experimental operation, corresponding to the maturity of the wor' . It is in the advance planning phase. Status of individual studies is given. (LK)

TRANSPORT AND STORAGE

REFER ALSO TO CITATION(S) 36927, 36983, 37008, 37695, 38303

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 36906

36924 **U.S. uranium requirements.** Hogerton, J.F. pp 43-51 of Uranium supply anddemand. London; Mining Journal Books (1977).

From 2. symposium on uranium supply and demand; London, UK (22 Jun 1977).

See CONF-7706120—.

The subject is discussed by reference to the following diagrams: U.S. nuclear power growth projection; projection of annual U.S. uranium requirements.

36925 **U.S. uranium supply outlook.** Hogerton, J.F. pp 162-176 of Uranium supply and demand. London; Mining Journal Books (1977).

From 2. symposium on uranium supply and demand; London, UK (22 Jun 1977).

See CONF-7706120—.

The subject is analysed in the light of figures and forecasts contained in the following diagrams: forecasts of U.S. uranium production, 1977 to 1990; indicated relationship between annual U.S. uranium supply and demand, 1977 to 1986; presently indicated cumulative U.S. uranium supply/demand balance, 1977 to 1990; indicated cumulative U.S. supply/demand balance (shortage or surpluses) 1976 to 1990; presently indicated balance between outstanding U.S. utility procurement needs and uncommitted domestic supply capability 1977 to 1986; projected U.S. uranium requirements in relation to existing supply base and presently indicated additional domestic resource potential, 1977 to 2000.

36926 **Uranium demand as judged by electric utilities.** Messer, K.P. pp 52-61 of Uranium supply and demand. London; Mining Journal Books (1977).

From 2. symposium on uranium supply and demand; London, UK (22 Jun 1977).

See CONF-7706120—.

The subject is discussed in two parts, both illustrated by tables or diagrams: (1) nuclear electricity generating capacity, world-wide forecasts for 1977 to 1990; annual and cumulative natural uranium requirements, world-wide forecasts for 1977 to 1990; and (2) nuclear electricity generating capacity in the Federal Republic of Germany, forecasts on various assumptions for 1980 to 2000; uranium requirements of the Federal Republic of Germany in 1995 (on various assumptions).

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 37833

36927 (DOE/ET—0042) **Current activities in DOE's commercial waste management program.** (Department of Energy, Washington, D.C. (USA). Div. of Waste Management). Mar 1978. 19p. Dep. NTIS, PC A02/MF A01.

Deep geologic disposal of radioactive wastes is being studied. Packaging and storage of spent fuel are also considered. Potential sites at Hanford and NTS are discussed. Research on waste immobilization and supporting studies is reported. (DLC)

36928 (IAEA-R—1219-F) **Study of integral waste management systems and their effects on the environment in Thailand. Part of a coordinated programme on migration and disperios of radionuclides from storage of radioactive waste under various conditions in the terrestrial environment. Final report for the period 1 October 1972—30 September 1975.** Karasuddhi, P. (International Atomic Energy Agency, Vienna (Austria)). Feb 1976. 9p. Dep. NTIS (US Sales Only), PC A03/MF A01.

The research work carried out is divided into 3 parts: 1. Experimental study of sorption capacity of Sr-90, Cs-137 and radioactive liquid waste of OAEP onto soil and clay. 2. The fixation of radioactive sludge and resin in cement, gumcrete and bitumen. The results show that the sludge from the OAEP waste treatment plant can be fixed very well with concrete, gumcrete and bitumen, but the solidification of resin in concrete, gumcrete and bitumen is not a good method for waste treatment. In the third part, the results of environment studies around the nuclear research center are presented.

36929 **Some aspects and long-term problems of high-level and actinide-contaminated spent fuel reprocessing wastes from the U-Pu and Th-U fuel cycles.** Haug, H.O. (Gesellschaft fuer Kernforschung mbH, Inst. fuer Heisse Chemie, Karlsruhe, Germany, F.R.). pp 233-241 of Management of radioactive wastes from thenuclear fuel cycle. Vol. 2. Vienna; IAEA (1976).

From IAEA symposium on the management of radioactive waste; Vienna, Austria (22 Mar 1976).

See CONF-760310—; STI/PUB-433(Vol.2).

A comparison is made of the long-term radiotoxicity of different high-level and actinide-containing wastes from nuclear fuel reprocessing and of naturally occurring radioactive materials. The

radiotoxicity of the radionuclide inventory in solid or solidified wastes fixed in a practicable insoluble matrix is compared with the radiotoxicity of the nuclide inventory of the same amount of uranium ores (0.2 wt% U), which consequently allowed the definition of a relative toxicity index. The comparison is extended to high-level waste disposed of in single bore holes in deep geological formations. The results indicate that after about 1000 years of decay the radiotoxicity of the controlling actinides in the total volume of the high-level waste disposal layer will not be higher than the radiotoxicity of the same amount of a low grade uranium ore deposit containing 0.2 wt% U. The concentration limitations preset by the single bore hole disposal geometry can also be met by similar disposal conditions for other actinide-containing wastes.

36930 (PNL—2377-3) **Nuclear waste management. Quarterly progress report, July—September 1977.** Platt, A.M. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Jan 1978. Contract EY-76-C-06-1830. 75p. Dep. NTIS, PC A04/MF A01.

Significant research during this period was reported on: decontamination and densification of chop-leach cladding residues; monitoring methods for particulate and gaseous effluents from waste solidification processes; krypton solidification; ^{14}C and ^{129}I fixation; waste management studies and safety assessment; waste isolation safety assessment; monitoring and physical characterization of unsaturated zone transport; detection and characterization of mobile organic complexes of fission products; and electropolishing for surface decontamination of metals. (DLC)

36931 (PNL—2598) **Summary of national and international radioactive waste management programs (excluding United States).** Harmon, K.M. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Mar 1978. Contract EY-76-C-06-1830. 54p. Dep. NTIS, PC A04/MF A01.

This report is divided into two parts. Various national fuel cycle and waste management programs are summarized in tabular form in the first part. The second part of the report gives a nation-by-nation overview of fuel cycle and waste management technologies. Brief summaries on the activities of several international organizations are included. (LK)

36932 Management of plutonium-contaminated wastes at the plutonium fuel facilities in PNC. Ohtsuka, K.; Miyo, H.; Ohuchi, J.; Shiga, K.; Muto, T.; Akutsu, H. (Power Reactor and Nuclear Fuel Development Corp., Tokai, Ibaraki (Japan). Tokai Works). pp 201-209 of Management of radioactive wastes from the nuclear fuel cycle. Vol. 2. Vienna; IAEA (1976).

From IAEA symposium on the management of radioactive waste; Vienna, Austria (22 Mar 1976).

See CONF-760310—; STI/PUB—433(Vol.2).

A summary of experience in the management of plutonium contaminated wastes at the plutonium fuel facilities of the Power Reactor and Nuclear Fuel Development Corporation (PNC) is presented. Descriptions are given of waste generation, current handling techniques, plutonium measurement techniques and process techniques now under research and development such as an incineration system and closed-cycle liquid waste treatment by decomposition of the ammonium nitrate contained in the liquid.

36933 ERDA's long-term waste management goals and programs. Perge, A.F.; Trice, V.G. Jr.; Walton, R.D. Jr. (Energy Research and Development Administration, Washington, D.C. (USA). Div. of Nuclear Fuel Cycle and Production). pp 3-13 of Management of radioactive wastes frm the nuclear fuel cycle. Vol. 1. Vienna; IAEA (1976).

From IAEA symposium on the management of radioactive waste; Vienna, Austria (22 Mar 1976).

See CONF-760310—; STI/PUB—433(Vol.1).

This paper presents an overview of the ERDA's major program for the long-term waste management of radioactive waste and provides a perspective for symposium participants with regard to the interrelationship of specific components of the program that are discussed in detail in other ERDA-sponsored papers. Needs, goals, and plans are reviewed for ERDA's management of the commercially generated wastes which are expected to be delivered to ERDA in accordance with Federal regulations. At present, ERDA responsibilities include long-term management of commercial-level wastes. Possible future regulations may give ERDA responsibility for the long-term management of commercial low-level solid wastes contaminated with transuranic nuclides. Primary planning goals and programs for the development of terminal storage facilities and waste processing technology to produce acceptable waste forms for long-term management are reviewed for each of the waste types identified above. The status of development programs for the long-term management of airborne radionuclides, which may be required at some time in the future, is also reviewed.

36934 Management of highly active decladding Zircaloy solid wastes from a fuel reprocessing plant. Balu, K.; Ramachandran, S.; Jain, B.K. (Bhabha Atomic Research Centre, Bombay (India)). pp 179-183 of Management of radioactive wastes from thenuclear fuel cycle. Vol. 1. Vienna; IAEA (1976).

From IAEA symposium on the management of radioactive waste; Vienna, Austria (22 Mar 1976).

See CONF-760310—; STI/PUB—433(Vol.1).

Handling and disposal of Zircaloy fuel cladding material is one of the major aspects in the management of radioactive wastes from a fuel reprocessing plant using the chop-leach technique. The paper describes the system for collection, transport and disposal of Zircaloy hull chips with an expected radiation dose rate of 10^4 R/h from the Tarapur Fuel Reprocessing Plant. Design features of the shipping cask for the hull wastes are presented. Details of the handling systems provided both for the in-plant movement of the hull from the chopper cell and at the disposal end are described. Design details of underground steel-lined concrete tile holes for the disposal of the hull wastes are presented. Environmental surveillance and monitoring methods adopted at the disposal are also discussed. Data on the capital investment and recurring costs for management of Zircaloy hull wastes are indicated.

36935 Chemical decontamination and melt densification of chop-leach fuel hulls. Dillon, R.L.; Griggs, B.; Kemper, R.S.; Nelson, R.G. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). pp 185-197 of Management of radioactive wastes from the nuclear fuel cycle. Vol. 1. Vienna; IAEA (1976).

From IAEA symposium on the management of radioactive waste; Vienna, Austria (22 Mar 1976).

See CONF-760310—; STI/PUB—433(Vol.1).

This paper reports on decontamination and densification studies of chop-leach fuel hull residues designed to minimize the transuranic element (TRU) contaminated waste stream. Decontamination requirements have been established from studies of TRU element distribution in the fuel hull residues. Effective surface decontamination of Zircaloy requires removal of zirconium oxide corrosion products. Good decontamination factors have been achieved with aqueous solutions following high temperature HF conditioning of oxide films. Molten fluoride salt mixtures are effective decontaminants, but pose problems in metal loss and salt dragout. Molten metal decontamination methods are highly preliminary, but may be required to reduce TRU originating from tramp uranium in Zircaloy. Low melting (1300°C) alloy of Zircaloy, stainless steel, and Inconel have been prepared in induction heated graphite crucibles. High quality ingots of Zircaloy-2 have been prepared directly from short sections of descaled fuel clad tubing using the Inductoslag process. This material is readily capable of refabrication. Inductoslag melts have also been prepared from heavily oxidized Zircaloy tubing demonstrating melt densification without prior decontamination is technically feasible. Hydrogen absorption kinetics have been demonstrated with cast Zircaloy-2 and cast Zircaloy-stainless steel-Inconel alloys. Metallic fuel hull residues have been proposed as a storage medium for tritium released from fuel during reprocessing.

36936 Development and radiation stability of glasses for highly radioactive wastes. Hall, A.R.; Dalton, J.T.; Hudson, B.; Marples, J.A.C. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). pp 3-13 of Management of radioactive wastes from the nuclear fuel cycle. Vol. 2. Vienna; IAEA (1976).

From IAEA symposium on the management of radioactive waste; Vienna, Austria (22 Mar 1976).

See CONF-760310—; STI/PUB—433(Vol.2).

The variation of formation temperature, crystallizing behaviour and leach resistance with composition changes for sodium-lithium borosilicate glasses suitable for vitrifying Magnox waste are discussed. Viscosities have been measured between 400 and 1050°C. The principal crystal phases which occur have been identified as magnesium silicate, magnesium borate and ceria. The leach rate of polished discs in pure water at 100°C does not decrease with time if account is taken of the fragile siliceous layer that is observed to occur. The effect of 100 years' equivalent α- and β-irradiation on glass properties is discussed. Stored energy release experiments demonstrated that energy is released over a wide temperature range so that it cannot be triggered catastrophically. Temperatures required to release energy are dependent upon the original storage temperature. Helium release is by Fick's diffusion law up to at least 30% of the total inventory, with diffusion coefficients similar to those for comparable borosilicate glasses. Leach rates were not measurably affected by α-radiation. β-radiation in a Van de Graaff accelerator did not change physical properties, but irradiation in an electron microscope caused minute bubbles in lithium-containing glasses above 200°C.

36937 Operational experience and developmental activities in waste management at Trombay. Ramani, M.P.S.; Panicker, P.K.; Mohan, A.L.; Rajan, M.V.; Kharbanda, J.L. (Bhabha Atomic Research Centre, Bombay (India)). pp 153-159 of Management of

radioactive wastes from the nuclear fuel cycle. Vol. 1. Vienna; IAEA (1976).

From IAEA symposium on the management of radioactive waste; Vienna, Austria (22 Mar 1976).

See CONF-760310—; STI/PUB—433(Vol.1).

The paper describes the operational innovations in the effluent treatment plant at Trombay, which has been in successful operation for about nine years. The effluent treatment plant, which is a combined facility for providing chemical and ion-exchange treatments for liquid effluents, has undergone a few modifications in the recent years. They have been carried out with a view to improving the plant performance and reducing some operational problems experienced earlier. The innovations implemented include, among others, the commissioning of a settling plant, installation of an efficient in-line mixing system and design and installation of a sludge transfer system for handling the transfer of highly active sludge concentrates from the settling plant. It has been observed from subsequent operations of the modified system that the quantity of sludge obtained had been consistently in the order of 0.6% of the volume of the effluents treated as against 1.9% earlier. Because of the much smaller volume of sludge obtained, it has been decided to fix the sludge directly in a suitable matrix after reducing the volume further by solar evaporation at the final storage site. Modifications being carried out at the radioactive storage site for the fixation of the above sludge and various other types of waste are also described. This paper also covers the new R and D activities being pursued for establishing technically and economically more viable chemical processes in treating such wastes. A process was developed for the removal of radioiodine from liquid effluents. It involves coprecipitation of iodine on bismuth hydroxide thus avoiding the use of costly silver salts. In addition, a method involving pretreatment with permanganate followed by precipitation of hydrous manganese dioxide was developed for the elimination of interfering organic matters and scavenging of important radionuclides.

36938 Co-operation between member states of the Council for Mutual Economic Assistance (CMEA) in radioactive waste treatment and burial. Tolpygo, V.K.; Friedrich, B. (Sovet Ehkonomicheskoj Vzaimopomoshchi, Moscow (USSR)). pp 77-81 of Management of radioactive wastes from the nuclear fuel cycle. Vol. 1. Vienna; IAEA (1976).

From IAEA symposium on the management of radioactive waste; Vienna, Austria (22 Mar 1976).

See CONF-760310—; STI/PUB—433(Vol.1).

For a number of years, CMEA Member States have been developing co-operation in radioactive waste treatment and burial. The authors describe the stages of this development and present some results of work done during the period 1971 to 1975 in connection with the co-operation programme for 'research on the management of liquid, solid and gaseous radioactive waste and the deactivation of contaminated surfaces'. Considerable attention is paid to the burial of radioactive waste of all kinds in geological formations. The authors also indicate the main features of the programme for scientific co-operation in this field between CMEA Member States planned for the period 1976 to 1980.

36939 Long-term planning for management of aqueous wastes from fuel reprocessing plants. Sunder Rajan, N.S.; Ravindranath, V.; Kumra, M.S.; Sinha Ray, M.K.; Thomas, K.T. (Bhabha Atomic Research Centre, Bombay (India)). pp 15-21 of Management of radioactive wastes from thenuclear fuel cycle. Vol. 1. Vienna; IAEA (1976).

From IAEA symposium on the management of radioactive waste; Vienna, Austria (22 Mar 1976).

See CONF-760310—; STI/PUB—433(Vol.1).

The Indian policy on management of high- and intermediate-level liquid wastes from fuel reprocessing plants is reviewed. The estimated generation of such wastes in the country for the next 25 years is projected. An analysis of the step-wise approach adopted for the management of such wastes is analysed with reference to the policy alternatives available, site and time constraints etc. Need for conditioning the wastes and methods adopted, solid matrix and solidification process, and interim storage of the solidified wastes are discussed. The approach to ultimate storage/ disposal of the solidified wastes in geological media is also analysed.

WASTE PROCESSING

REFER ALSO TO CITATION(S) 36991

36940 (BNWL—2063) **Selection and evaluation of processes for recovery of beneficial isotopes from commerical reactor wastes.** Davis, D.K.; Partridge, J.A.; Koski, O.H. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Dec 1977. Contract EY-76-C-06-1830. 32p. Dep. NTIS, PC A03/MF A01.

Conceptual processes were prepared for recovering isotopes from stored high-level liquid wastes to define equipment and facility requirements. Capital costs were estimated for each process. Four different facilities were studied for potential isotope recovery. The processes were for the recovery of: cesium only; strontium only; cesium and strontium; and cesium, strontium, promethium, americium, curium, neptunium, and the platinum metals. The selection of these recovery processes was determined by their possible effect on the waste management system. The isotope recovery processes selected tended to have a minimal effect on this system. Preliminary capital investment costs for the four types of facilities processing HLLW from a 5 MT/day reprocessing plant were estimated to be: $37 million for a cesium or a strontium recovery facility; $51 million for a facility recovering cesium and strontium; and $143 million for a multi-product facility. In all cases the recovery facility was assumed to be closely integrated with a fuel reprocessing plant and designed along with the reprocessing plant. Recovery costs were estimated for the various products, assuming 50 percent recovery from the HLLW for all of the products, except the platinum metals; 25 percent recovery was assumed for these metals. In general, product price estimates (in 1977 dollars) assumed a market for all of the recovered materials. Estimates for cesium ranged from 45 cents/Ci of ^{137}Cs (at 69 MCi/yr) in a cesium-only recovery facility to 31 cents/Ci in a plant recovering both cesium and strontium. Strontium estimates ranged from 60 cents/Ci of ^{90}Sr (at 51 MCi/yr) in a strontium-only recovery facility to 42 cents/Ci in a cesium and strontium recovery facility.

36941 (CONF-771139—1) **Separation of tritium from gaseous and aqueous effluent systems.** Kobisk, E.H. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 36p. Dep. NTIS, PC A03/MF A01.

From Radioactive effluents from nuclear fuel reprocessing plants seminar; Karlsruhe, F.R. Germany (22 Nov 1977).

Three processes are discussed for separating tritium from gaseous and aqueous effluent systems: separation in the gas phase using Pd-25 wt percent Ag alloy diffusion membranes; electrolytic separation in the aqueous phase using "bipolar" electrodes; and the countercurrent exchange of tritium-containing hydrogen gas with water on catalytic surfaces combined with separation by direct electrolysis. (LK)

36942 (CONF-780316—7) **Biological processes for environmental control of effluent streams in the nuclear fuel cycle.** Shumate, S.E. II; Hancher, C.W.; Strandberg, G.W.; Scott, C.D. (Oak Ridge National Lab., Tenn. (USA)). 1978. Contract W-7405-ENG-26. 15p. Dep. NTIS, PC A02/MF A01.

From Waste management fuel cycles; Tucson, AZ, USA (5 Mar 1978).

Nitrates and radioactive heavy metals need to be removed from aqueous effluent streams in the fuel cycle. Biological methods are being developed for reducing nitrate or nitrite to N_2 gas and for decreasing dissolved metal concentration to less than 1 g/m^3. Fluidized-bed denitrification bioreactors are being tested. Removal of uranium from solution by Saccharomyces cerevisiae and Pseudomonas aeruginosa was studied. (DLC)

36943 (DP-MS—77-87) **Pyrolysis model for an alpha waste incinerator prototype.** Orloff, D.I. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). 1978. Contract EY-76-C-04-0789. 31p. (CONF-780520—1). Dep. NTIS, PC A03/MF A01.

From 2. thermophysics and heat transfer conference; Palo Alto, CA, USA (24 May 1978).

The development of a theoretical model of the pyrolysis stage of an SRL prototype alpha waste incinerator is discussed. Pyrolysis rates for single component porous beds of Teflon (Registered trademark of Du Pont) and natural rubber have been measured on a bench-scale furnace. Experimental pyrolysis rates compare favorably to the predictions of a quasi-steady regression model. In addition, the pyrolysis rate is shown to be a weak function of the thermal diffusivity of the porous polymer bed. As a consequence, pyrolysis is controlled by thermal degradation kinetics rather than by diffusion or conduction.

36944 (KFK—2435, pp 152-176) **Separation of krypton and xenon from the off gas of nuclear facilities.** von Ammon, R.; Franz, G.; Strauch, K.; Weinlaender, W.; Wurster, W. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Heisse Chemie); Hauss, E.; Hutter, E.; Neffe, G.; Pfeifer, W. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Abt. Reaktorbetrieb und Technik). Apr 1977. (In German).

In Second semiannual report 1976.

During the first period of operation of the KRETA plant decontamination factors were obtained using the two-component system N_2-Ar und N_2-Kr which corresponded fairly well with values previously calculated (DF (Ar) = 10, DF (Kr) > 10^3). The separation Kr-Xe in the second column resulted in a Kr head product of 99.99% purity and a Xe bottom product containing < 100 ppm Kr. A detector for the determination of H_2 was developed

showing no poisoning by NOsub(x). The experiments on the thermal reduction of O_2 and NOsub(x) with H_2 showed that only at temperatures > 1,100°C reaction rates are short enough to provide high yields. Dynamic adsorption coefficients of NH_3 on two acid resistant molecular sieves are only about half as high as on the conventional type 5A. The presence of H_2O in the gas stream increases the NH_3 adsorption. The desorption of NO_2 proceeds in several temperature steps. The separation Kr-Xe by means of selective desorption from activated charcoal (vacuum of purging with N_2 or H_2O-vapor) is feasible, but relatively large adsorption beds are required for large process gas streams.

36945 (KFK—2435, pp 127-139) **Determination of the radioiodine species in the exhaust air of nuclear facilities.** Deuber, H. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Lab. fuer Aerosolphysik und Filtertechnik). Apr 1977. (In German).

In Second semiannual report 1976.

Using the selective I_2 sorption materials DSM 10 and DSM 11 measurements were performed with radioiodine species samplers in the exhaust air of a research reactor and of several nuclear power stations (BWR, PWR). The radioiodine species samplers were used upstream and downstream of iodine filters (containment exhaust air stand-by filter, shutoff room exhaust air filter) as well as in the exhaust air of the stack. The results obtained by use of DSM 10 and DSM 11 generally agreed. The percentage of aerosol iodine was low in all cases (< = 3%) whereas that of organic iodine partly reached high values (< = 77%). In case of complete iodine filtering of the air the percentage of inorganic iodine was very low (< = 2%).

36946 (KFK—2435, pp 113-124) **Development of exhaust air filters for reprocessing plants.** Furrer, J.; Kaempffer, R.; Wilhelm, J.G. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Lab. fuer Aerosolphysik und Filtertechnik). Apr 1977. (In German).

In Second semiannual report 1976.

Work completed: 1. An iodine and aerosol test rig was built jointly with GWK in a caisson in WAK and accepted by the TUeV (Technical Inspectorate). An in-line iodine measuring probe was installed in the dissolver off-gas line. 2. Sampling systems for the dissolver and vessel off-gas were designed and built for examination of the gaseous components. 3. High loading level and desorption tests were carried out in the laboratory with AC 6120/H_1 as the iodine sorption material. 4. The flowsheet for PASSAT and all the technical criteria for delivery and acceptance and specifications for the components and examination of the bids were begun. 5. Fabrication and partial testing of a prototype iodine filter (box design) were completed. Results: Ad. 1. In principle, iodine measurements can be performed with the existing iodine measuring system. Improvements were achieved and tested in prolonging the service life of the system. Also a parallel development seems to be successful. Ad 2. First samples were taken to determine the concentration of organic constituents in the vessel off-gas of the WAK facility. Ad 3. In the case of iodine concentration peaks of > 10 g I_2/m^3 of off gas there is physical adsorption on the iodine sorption material in addition to chemisorption. The optimization of a sweep phase for further transport of the adsorbed iodine up to the point of binding by chemisorption in deeper layers of the filter will be the object of further studies. Ad 4. The assembly structure to accommodate the whole system has been set up. Technical discussions about the adjudication of the contract for the plant have in part been finished. Ad 5. Partial testing of the prototype iodine filter (box design) produced good results in long time and handling tests.

36947 (KFK—2435, pp 125-126) **Ageing and poisoning of iodine sorption materials.** Furrer, J.; Kaempffer, R.; Wilhelm, J.G. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Lab. fuer Aerosolphysik und Filtertechnik). Apr 1977. (In German).

In Second semiannual report 1976.

Studies relating to the reduction of the ^{131}I removal efficiency of activated charcoals in iodine filters due to loading by poisons as well as studies of the regeneration of poisoned activated charcoals have been continued and extended to the determination of radioiodine volatility during the phase of desorption. Even after high loading by poisons of activated charcoal as a result of extended exposure in the nuclear power station the initial removal efficiency was nearly attained by a poison desorption cycle. A first test showed that not much of the iodine activity already removed was discharged during the desorption phase.

36948 (MLM—2502) **Tritium waste control, October—December 1977.** (Mound Facility, Miamisburg, Ohio (USA)). 4 Mar 1978. Contract EY-76-C-04-0053. 30p. Dep. NTIS, PC A03/MF A01.

The combined electrolysis-catalytic-exchange pilot scale system was operated on a 5 hr/day basis for 32 days without a major equipment failure. Modifications were made to the Nd:YAG laser that increased the output power by five. The increased beam quality and power of the laser allowed optical parametric oscillator (OPO) operation over a 2.9 to 4.14 μm tuning range. Background exchange was eliminated in the photolysis system and photolytic experiments were commenced. Photo dissociation experiments with H_2O/D_2 revealed that the xenon flashlamp should have sufficient spectral emittance in the less than or equal to 194 nm region to produce detectable amounts of photodissociation in vibrationally excited HDO. The short 10 cm long x 0.6 cm i.d. column was replaced by a 50-cm-long column of the same diameter. A thermometer was placed at the midpoint of the column to assist in the analysis of column operation. A new liquid level probe was installed. Tests of stage height were repeated with the longer column. Triplicate samples of cement, cement-plaster (1:1 ratio by weight), and cement-plaster (1:1 ratio by volume) were injected with 386 Ci of tritium, cured for five days, and then impregnated with catalyzed styrene monomer. After polymerization, the samples were put into a test program to measure the tritium release. When the polystyrene bottle was removed the tritium release increased fiftyfold. This corresponds to a fractional release of 2.8 x 10^{-1} after 31 weeks. The tritium release study of actual burial packages is continuing. Two additional drums have just been added to the study. These contain octane waste. The fractional release is 1 x 10^{-5} on a 5-yr old package, only 4.0 x 10^{-7} on a 4-yr old package, and 4.7 x 10^{-9} on the 2-yr old package.

36949 (ORNL/TM—5757) **Experiments with a lime slurry in a stirred tank for the fixation of carbon-14-contaminated CO_2 from simulated HTGR fuel reprocessing off-gas.** Holladay, D.W. (Oak Ridge National Lab., Tenn. (USA)). Mar 1978. Contract W-7405-ENG-26. 105p. Dep. NTIS, PC A06/MF A01.

The fixation of CO_2 with a lime slurry in a stirred tank reactor appears to be feasible. The rate of reaction is fast, and virtually complete removal of CO_2 can be attained. At a gas residence time of <1 min, the decontamination factor (DF) is >100 in a single stage reactor for CO_2 concentrations ranging from 5 to 100%. It has been determined that two-stage contacting sequences which result in a cumulative DF > 10^4 are feasible. The reaction rate is constant up to 90% utilization of the lime and then rapidly decreases, as does the pH for the remainder of the reaction. The reaction appears to be liquid-phase-controlled, and the overall gas-side mass transfer coefficient (K/sub G/α) increases with impeller speed and gas flow rate, ranging from 0.4 x 10^{-6} to 6 x 10^{-6} g-moles of CO_2 per (cm^3-sec-atm). The reaction rate data are also correlated by a model of mass transfer accompanied by a fast pseudo first-order chemical reaction from which good agreement of calculated and predicted interfacial area is obtained. It was noted that temperature (21 to 46°C) and lime concentration (0.5 to 1.5 M) had very little effect on mass transfer rate and DF. The settling rate of the $CaCO_3$ product increased significantly with impeller speed and temperature and decreased with gas flow rate. Scale-up calculations indicate that reasonably sized equipment would provide adequate removal of CO_2 for a full-scale reprocessing plant.

36950 (ORNL/TM—5869) **Experimental engineering section off-gas decontamination facility's fractionator column: installation and performance.** Gilliam, T.M.; Fowler, V.L.; Inman, D.J. (Oak Ridge National Lab., Tenn. (USA)). Mar 1978. Contract W-7405-ENG-26. 78p. Dep. NTIS, PC A05/MF A01.

A detailed description of the third column recently installed in the Experimental Engineering Section Off-Gas Decontamination Facility (EES-ODF) is presented. The EES-ODF is being used to provide engineering-scale experiments (nominal gas and liquid flows of 5 scfm and 0.5 gpm, respectively) in the development of the Krypton Absorption in Liquid CO_2 (KALC) process. A detailed discussion of the column's construction is provided. This discussion includes the peripherals associated with the column, such as refrigeration, heat exchangers, instrumentation, etc. The compressibility of Goodloe packing (the packing in the other columns) and the possible reduced throughput due to this compression have revealed the desirablility of a random (i.e., noncompressible) packing. Toward this end, the third column is packed with a new random packing (PRO-PAK). A preliminary comparison between this packing and the woven wire mesh packing (Goodloe) used in the other two columns has been made. Experiments comparing the throughput capacity indicate that the PRO-PAK packing has approximately 60% the capacity of Goodloe for a CO_2 system. When used as a fractionator or stripper with the basic O_2-Kr-CO_2 KALC system, the PRO-PAK column produced HTU values less than or equal to the GOODLOE columns under similar operating conditions.

36951 (ORNL/TM—6174) **Actinide partitioning and transmutation program. Progress report, July 1—September 30, 1977.** Tedder, D.W.; Blomeke, J.O. (comps.). (Oak Ridge National Lab., Tenn. (USA)). Feb 1978. Contract W-7405-ENG-26. 213p. Dep. NTIS, PC A10/MF A01.

In Purex process modifications, two cold runs with mixer-settlers were made on the extraction and stripping of ruthenium and zirconium without the presence of uranium. Efforts in actinide recovery from solids were directed toward the determination of dissolution parameters in various reagents for ^{241}Am and ^{239}Pu oxide mixtures, ^{233}U oxide, ^{237}Np oxide, ^{244}Cm oxide, ^{232}Th oxide, and PuO_2. Studies in americium-curium recovery with OPIX (oxalate

precipitation and ion exchange), Talspeak, and cation exchange chromatography focused on the feasibility of forming oxalate precipitates in continuous systems, the effects of zirconium on Talspeak, and methods for removing solvent degradation products of the Talspeak system. In studies of americium-curium recovery using bidentate extractants, additional distribution coefficients for actinides and other key elements between reduced synthetic LWR waste solution and 30 percent dihexyl-N, N-diethylcarbamylmethylene phosphonate in diisopropylbenzene were measured. Studies in the americium-curium recovery using inorganic ion exchange media to determine the pH dependence of lanthanide ion affinity for niobate, titanate, and zirconate ion exchange materials have been completed. A modified flowsheet for the extraction of uranium, neptunium, plutonium, americium, and curium from high-level liquid waste is presented. Evaluation of methods for measuring actinides from incinerator ash is continuing. A preliminary evaluation of methods for treatment of salt waste and waste waters was completed. In thermal reactor transmutation studies, waste actinides from an LWR lattice containing mixed uranium-plutonium assemblies were recycled in separate target assemblies. (LK)

36952 (PNL—2486) **Critical assessment of methods for treating airborne effluents from high-level waste solidification processes.** Christian, J.D.; Pence, D.T. (Scientific Advances, Inc., Columbus, Ohio (USA)). Jun 1977. Contract EY-76-C-06-1830. 162p. (SAI—77-571-LJ). Dep. NTIS, PC A08/MF A01.

Off-gas treatment systems are reviewed for high-temperature processes which are being developed for the solidification of high-level liquid wastes from nuclear fuel reprocessing plants. A brief description of each of the processes is given and detailed analyses are made of the expected magnitudes of airborne effluent release rates from each system. The estimated release rates of the various processes are compared with present and anticipated regulatory limits. A number of recommendations are made for additional development studies to better understand and control certain airborne effluents from the solidification processes.

36953 Oxidation and degradation of short-chain aliphatic compounds by hyperazeotropic nitric acid. Clark, W.E.; Howerton, W.B.; Benjamin, B.M.; Baldwin, W.H. (Oak Ridge National Lab., TN). *Nucl. Sci. Eng.;* **66**: No. 1, 110-117(Apr 1978).

To determine the ultimate fate of organic material present in nuclear fuel reprocessing solutions and the chemical nature of the last surviving residues, organic products of the hydrolysis/nitrolysis of tributyl phosphate were subjected to further degradation with boiling 20 M HNO_3 (Iodox Process) and carbon balances were run. Except for methyl nitrate, nitrate esters were oxidized in refluxing 20 M HNO_3, primarily to a mixture of carbon dioxide and the corresponding and shorter chain aliphatic acids. Typically, 40% or more of the carbon from the nitrate esters was converted to CO_2. Except for formic acid, the straight-chain monobasic acids oxidized slowly. Compounds identified among those resulting from oxidation of butyric acid (e.g., from the oxidation of butyl nitrate) included succinic and oxalic acids, 3- and 4-hydroxy-butyric acids, nitrate esters of 3- and 4-hydroxybutyric acid, butyrolactone, and 3-nitrobutyric acid. The mechanisms for formation of these products are briefly discussed. Oxalic acid and the hydroxyaliphatic acids have some potential for complexing ceertain metallic fission products. These results show that traces of organic materials will always be present in actual fuel processing solutions unless special measures are taken to ensure their removal. This conclusion was reinforced by analysis of recycle acid from the Savannah River Plant. The possible implications to a reprocessing plant using 100% recycle are briefly discussed.

36954 Vitrification of highly active liquid waste. I. Thermal decomposition of nitrates and additives for glass-making. Chun, K.S.; Lee, S.H. *J. Korean Nucl. Soc.;* **9**: No. 4, 211-222(Dec 1977).

The decomposition of all the individual chemicals used in the Harwell inactive vitrification pilot plant was studied by means of a thermal balance. Weight loss curves to 1100°C were obtained. Sodium nitrate, cesium nitrate, lithium nitrate, and ruthenium nitroso-nitrate solution showed a greater weight loss than that based on an oxide yield, and hence these compounds of their products of decomposition are volatile below 1100°C. The remaining materials suffered a weight loss no more than that corresponding to a full yield of the oxide, and hence they were not volatile below 1100°C. Most of chemicals begin to decompose at less than 75°C but the nitrates of cesium, strontium, barium and sodium not until 295 to 590°C. The results can be used in the analysis of process conditions in the vitrification and calcination of highly radioactive wastes and also of the thermal decomposition behavior of mixtures containing those materials. 20 figures.

36955 Operational techniques to minimize, segregate and account for alpha-bearing wastes. Johnson, L.F. (British Nuclear Fuels Ltd., Sellafield). pp 191-199 of Management of radioactive wastes from thenuclear fuel cycle. Vol. 2. Vienna; IAEA (1976).

From IAEA symposium on the management of radioactive waste; Vienna, Austria (22 Mar 1976).

See CONF-760310—; STI/PUB—433(Vol. 2).

The paper presents an account of the measures being adopted at the Windscale Works of British Nuclear Fuels Limited to reduce arisings of plutonium-contaminated solid waste by a combination of good design, provision of equipment and suitable operating materials and education of operators, following detailed examination of the pattern of waste arisings. The segregation system for packaged waste is described and the reasons for it are explained. The various categories of waste are chosen according to the disposal, treatment and storage routes available. The routes presently available for drummed plutonium-contaminated waste include sea disposal via annual internationally-regulated dumps in the deep Atlantic, incineration and intermediate term storage pending the development of further treatment methods. The figures used for accounting are determined by instrumental non-destructive analysis in the central waste handling facility. The methods presently available are described with their limitations. Instruments which are expected to become available during 1976 are described briefly. These consist of a segmented gamma scanning instrument, an NNC 'random driver' neutron interrogation instrument and a means of determining the plutonium content of crated waste. A description is given of the data managment system, which provides the information on plutonium losses to waste which is incorporated into the fissile material account for each area.

36956 Recent experiments on the treatment of medium level wastes and spent solvent and on fixation into bitumen. Baehr, W.; Hild, W.; Drobnik, S.; Kahl, L.; Kelm, M.; Kluger, W.; Krause, H. (Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (Germany, F.R.)); Finsterwalder, W. (Gesellschaft zur Wiederaufarbeitung von Kernbrennstoffen m.b.H., Eggenstein-Leopoldshafen (Germany, F.R.)); Ruth, W. (Nuklear-Chemie und -Metallurgie G.m.b.H. (NUKEM), Hanau (Germany, F.R.)). pp 133-141 of Management of radioactive wastes from the nuclear fuel cycle. Vol. 2. Vienna; IAEA (1976).

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See CONF-760310—; STI/PUB—433(Vol.2).

The paper gives a summary of the main research and development work performed at the Nuclear Research Centre Karlsruhe on the treatment of the low and medium level waste solutions that are expected to be produced in a typical large Purex-type reprocessing plant of 1500t U/a capacity. Results are presented that have been obtained in investigations accompanying the operation of the industrial bituminization plant of the Research Centre, which till now has produced about 2000 drums of solidified waste. A description of lab- and pilot-scale work on the destruction of nitric acid in medium level waste (MLW) solutions and evaporator concentrates by means of formic acid is given. A new approach for the treatment of MLW solutions that aims at a splitting into a very small fraction of high level waste and a low level waste solution of less or equal volume than the original MLW is presented, together with the first encouraging decontamination factors, averaging 10^2 to 10^3. A discontinuous procedure for the treatment of spent solvent containing TBP was successfully demonstrated by processing more than $100m^3$ of original reprocessing waste. Results are described, together with first investigations on the scale up to a continuous process version for a large reprocessing plant.

36957 Incorporation of radioactive wastes into heat-hardened resins. Baer, A.; Traxler, A.M. (Groupement pour les Activites Atomiques et Avancees (GAAA), 92 - Le Plessis-Robinson (France)); Limongi, A.; Thiery, D. (CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Service de Protection et des Etudes d'Environnement). pp 175-186 of Management of radioactive wastes from the nuclear fuel cycle. Vol. 2. Vienna; IAEA (1976). (In French)

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The paper discusses the process developed and used at the Grenoble Nuclear Research Centre for incorporating radioactive wastes into heat-hardened resins and the application of this process to the treatment of radioactive waste originating from nuclear power stations with light-water reactors (PWR and BWR). The various types of waste are listed and assessed in terms of their activity and quantity, for example, evaporator concentrates, ion-exchange resins, filtration sludges, filters, various solid wastes, and so forth. The paper describes the lines along which research has been conducted and indicates, for each type of waste under consideration, the processing cycle - ranging for example, from the insolubilization of radionuclides, through the drying of the concentrates, to final incorporation. A study is made of the safety aspects of the process while in operation and of the shipping and storage of the incorporated waste; the authors outline the main technical characteristics relating

to the safety of the plant and the final product obtained. More especially, they give the results of fire, irradiation, leaching and other types of endurance tests - characteristics which can be regarded in effect as safety criteria. Lastly, the authors touch on the economic aspect of the procedure by describing the contributions made in that respect by a reduction in volume and weight of the waste to be stored, the simplicity of the equipment and the cost of raw materials. They conclude that the sphere of application of heat-hardened resins appears, at the present stage of research and operational experience, to meet the requirements for the treatment of low- and medium-level waste.

36958 Pot-vitrification of fully radioactive fuel reprocessing wastes. Planning of hot-cell experiments. Bocola, W. (Comitato Nazionale per l'Energia Nucleare, Casaccia (Italy). Centro di Studi Nucleari). pp 303-312 of Management of radioactive wastes from the nuclear fuel cycle. Vol. 1. Vienna; IAEA (1976).

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See CONF-760310—; STI/PUB—433(Vol.1).

A pot-vitrification process has been developed for the fixation of fission products either in phosphate or borosilicate glasses. After some preliminary studies carried out with simulated fission product solution, hot bench-scale experiments have been planned to solidify fully radioactive wastes. To carry out the active experiments a suitable bench-scale plant with special provisions for remotely controlled operations has been designed and constructed. The components of the plant are to be assembled in one rack (1600X1200X2600mm) and the rack will be placed for operation in the 4305 hot cell of the irradiated fuel dismantling facility annexed to the Essor plant of Ispra CCR establishment. The operation of this plant with fully radioactive wastes is planned to be completed by the end of 1977. A maximum of five litres of concentrated fission prouct solution will be treated in each run, which should last about four days. The pot (50mmi.d.X500mm height) will be filled with 700-750ml(2-2.5kg) of melted glass. The glass refining temperature is in the range of 900 to 1050°C. Five different types of concentrated fission product solutions (10-100Ci/l) will be tested. About 20 active runs are planned; the activity content of each run will range from 10 to 500Ci.

36959 Considerations on nuclear transmutation for the elimination of actinides. Bocola, W.; Frittelli, L.; Gera, F.; Grossi, G.; Moccia, A.; Tondinelli, L. (Comitato Nazionale per l'Energia Nucleare, Casaccia (Italy). Centro di Studi Nucleari). pp 211-223 of Management of radioactive wastes from the nuclear fuel cycle. Vol. 2. Vienna; IAEA (1976).

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See CONF-760310—; STI/PUB—433(Vol.2).

The sensitivities of actinide build-up in LWRs in relation to variations in capture cross-sections, capture resonance integrals and decay constants, have been caculated. The flowsheet of a chemical process, potentially capable of separating the actinides from high-level waste with the required efficiency, has been outlined. The actinides are assumed to be recycled in fast breeders in special fuel pins. The half-residence time of the actinides in fast breeders is about nine years. In a first approximation it appears that the risk associated with nuclear transmutation could be greater than the risk resulting from disposal in a very favourable geological formation.

36960 Cryogenic separation of krypton and xenon from dissolver off-gas. Bohnenstingl, J.; Heidendael, M.; Laser, M.; Mastera, S.; Merz, E. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Chemische Technologie). pp 129-137 of Management of radioactive wastes from thenuclar fuel cycle. Vol. 1. Vienna; IAEA (1976).

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See CONF-760310—; STI/PUB—433(Vol. 1).

Although the release of fission product noble gas krypton-85 has not posed a health problem to date, a process is being developed for the removal and storage of fission product noble gases from the dissolution process stream of fuel reprocessing. The separation process described for noble gas in air being tested on a semi-technical scale includes cryogenic distillation and consists of the following steps: (i) removal of iodine-129 plus iodine-131 on silver-coated silica gel; (ii) deposition of particulate materials by HEPA-filters; (iii) elimination of O_2 and NOsub(x) by catalytic conversion with H_2 to N_2 and H_2O; (iv) drying of the gas stream with molecular sieve; (v) deposition of xenon in solid form at about 80K, while the remaining gas components are liquefied; (vi) enrichment of krypton by low-temperature distillation of liquid-gas mixture; (vii) withdrawal of the highly enriched krypton fraction at the bottom of the still to be bottled in pressurized steel cylinders for final disposal; (viii) purification of krypton-85 contaminated xenon for further industrial re-use by batch distillation.

36961 Studies on the incorporation of spent ion exchange resins from nuclear power plants into bitumen and cement. Bonnevie-Svendsen, M.; Tallberg, K. (Institutt for Atomenergi, Kjeller (Norway)); Aittola, P. (Valtion Teknillinen Tutkimuskeskus, Helsinki (Finland)); Tollbaeck, H. (Aktiebolaget Atomenergi, Studsvik (Sweden)). pp 155-173 of Management of radioactive wastes from the nuclear fuel cycle. Vol. 2. Vienna; IAEA (1976).

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CONF-760310—; STI/PUB—433(Vol.2).

The joint Nordic incorporation experiments should provide technical data needed for the assessment of solidification techniques for wastes from nuclear reactors in the Nordic countries. Spent ion exchange resins are a main fraction of such wastes, and more knowledge about their incorporation is wanted. The effects of simulated and real ion exchange wastes on the quality of bitumen and cement incorporation products were studied. Blown and distilled bitumen and three Portland cement qualities were used. Product characterizations were based on properties relevant for safe waste management, storage, transport and disposal. The applicability and relevance of established and suggested tests is discussed. Up to 40-60% dry resin could be incorporated into bitumen without impairing product qualities. Products with higher resin contents were found to swell in contact with water. The products had a high leach resistance. Their form stability was improved by incorporated resins. Product qualities appeared to be less affected by physico-chemical variables than by mechanical process parameters. Pure resin-cement products tend to decompose in water. Product qualities were strongly affected by a variety of physico-chemical process parameters, and integer products were only obtained within narrow tolerance limits. Caesium was rapidly leached out. To attain integer products and improved leach resistance within technically acceptable tolerance limits it was necessary to utilize stabilizing and caesium-retaining additives such as Silix and vermiculite. Under the present conditions the water content of the resins limited the amounts that could be incorporated in 40-50wt% or about 70vol.% water-saturated (containing 20-40% dry) resin.

36962 Treatment and control of gaseous effluents from light water reactors and reprocessing plants. Broothaerts, J.; Collard, G.; Bruggeman, A.; Goossens, W.R.A.; Baetsle, L.H. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)); Glibert, R. (Societe Belge pour l'Industrie Nucleaire, Brussels). pp 101-114 of Management of radioactive wastes from the nuclear fuel cycle. Vol. 1. Vienna; IAEA (1976).

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See CONF-760310—; STI/PUB—433(Vol.1).

The Belgian Nuclear Research Centre, SCK/CEN, in association with Belgonucleaire, has for many years been actively engaged in development work on the retention of gaseous radioactive wastes from reprocessing plants and power reactors. Two major goals are assigned to the R and D programme: the development of an effective means for the reduction of release of xenon isotopes from PWR reactor off-gases; and the development of an integrated gas-purification loop for the reduction of environmental releases of iodine, tritium and krypton at reprocessing plants. This programme is being carried out in laboratory and engineering-scale facilities. The main results obtained so far are reported.

36963 KS-KT-100 plant for two-stage vitrification of radioactive waste: results of tests with simulators. Davydov, V.I.; Dobrygin, P.G.; Dolgov, V.V.; Sergeev, G.A. (Nauchno-Issledovatel'skij Inst. Khimicheskogo Mashinostroeniya, Sverdlovsk (USSR)). pp 375-383 of Management of radioactive wastes from thenuclear fuel cycle. Vol. 1. Vienna; IAEA (1976). (In Russian)

From Meeting of Society of Photo-Optical Instrumentation Engineers; Palos Verdes Estates, CA, USA (22 Mar 1976).

See CONF-760318—; STI/PUB—433(Vol.1).

The Soviet Union has developed a two-stage process for phosphate vitrification of liquid radioactive waste involving the use, at the initial stage, of calcination in the pseudo-liquefied layer, followed by melting of the calcinate in a ceramic crucible (second stage). On the basis of the laboratory studies and bench tests using experimental equipment, the authors have developed and tried out an enlarged plant - the KS-KT-100. The plant includes units for preparing the solution, evaporation, calcination, melting and gas purification. The initial solution containing 240 g/litre of aluminium nitrate, 125 g/litre of sodium nitrate, 120 to 130 g/litre of orthophosphoric acid, and 90 to 150 g/litre of industrial molasses simulated fluxed nitrate waste. The tests have shown that the various units operate satisfactorily. The authors have determined the technological parameters for evaporation, calcination of the solution and melting of the calcinate. The presence of molasses in the solution (150 g/litre) makes it possible to decompose and distil 40% of the nitrate ion during evaporation. The calcination temperature is 350 to 400°C, and the fluidization rate 1.5 m/s. The capacity of the plant

for the initial solution is 100 litres/h, for the evaporated solution 65 litres/h, and for the glass 20 kg/h. The efficiency of the gas purification system ranges between 10^7 and 10^9. The test results show the feasibility of the two-stage method of vitrification in actual practice.

36964 Evaluation of products for the solidification of high-level radioactive waste from commercial reprocessing in the Federal Republic of Germany. Ewest, E.; Levi, H.W. (Hahn-Meitner-Institut fuer Kernforschung Berlin G.m.b.H. (Germany, F.R.). Bereich Kernchemie und Reaktor). pp 15-25 of Management of radioactive wastes from the nuclear fuel cycle. Vol. 2. Vienna; IAEA (1976).

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See CONF-760310—; STI/PUB—433(Vol.2).

The main purpose of the solidification product within the waste management scheme is to serve as a second barrier against release of radioactivity from the final disposal site. When defining the stability requirements quantitatively, the general philosophy is to make the product 'as stable as practical'. The stability categories to be considered are, in order of increasing significance: irradiation stability, thermal stability, mechanical stability, and chemical stability. The product groups to be analysed are calcines, glasses, ceramics and composites. The conclusion is that glasses are at present the first choice for waste solidification with the long-term emphasis on borosilicate glasses. Glass ceramics and metal matrix composites may be important advances to meet the 'as stable as practical' requirement.

36965 Solidification of high-level liquid wastes to phosphate glass-metal matrix blocks. van Geel, J.; Eschrich, H. (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)); Heimerl, W.; Grziwa, P. (Gelsenberg A.G., Essen (Germany, F.R.)). pp 341-358 of Management of radioactive wastes from thenuclear fuel cycle. Vol. 1. Vienna; IAEA (1976).

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See CONF-760310—; STI/PUB—433(Vol.1).

The production of active phosphate glass-metal matrix blocks has recently been accomplished in pilot-scale equipment. The process, developed jointly by the Gelsenberg AG and Eurochemic, comprises two main steps: (a) the continuous vitrification of the high-level liquid waste to phosphate glass beads, and (b) the incorporation of these beads into a metal matrix. The vitrification technology allows a reliable control of the quality of the phosphate glass product. The incorporation of the glass beads into a metal matrix results in a final product of high mechanical strength, low dispersability, high resistance to leaching and high thermal conductivity.

36966 Lab-scale and pilot-plant experiments on the solidification of high-level wastes at the Karlsruhe Nuclear Research Centre. Guber, W.; Hild, W.; Kaufmann, F.; Koschorke, H.; Krause, H.; Rudolph, G.; Saidl, J.; Scheffler, K. (Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (Germany, F.R.)). pp 291-280 of Management of radioactive wastes from the nuclear fuel cycle. Vol. 1. Vienna; IAEA (1976).

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See CONF-760310—; STI/PUB—433(Vol.1).

The paper reports on recent development activities on the solidification of HLW in borosilicate glass, which are performed on a lab-scale and in an inactively running pilot plant. The laboratory work is mainly concerned with the development of glass compositions suitable for the incorporation of more than 20% by weight of fission products and an additional 10% by weight of Gd_2O_3. Highly active glass specimens with more than 1000Ci/l of glass and ^{242}Cm doped glass samples with an α-activity of 2.6Ci/g of glass have been prepared, aiming at post-vitrification studies on glass structure, leachability, helium build-up, stored energy and diffusion phenomena. As an alternative to vitrification, the production of ceramic products by a thermite reaction is demonstrated. Further, the results of pilot-plant operation of the VERA process are reported. An advanced VERA concept with an integrated calciner/filter unit and continuous denitration in the spray calciner is described.

36967 Fuel reprocessing solvent tributyl phosphate. Its degradation, clean-up and disposal. Healy, T.V. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). pp 201-214 of Management of radioactive wastes from the nuclear fuel cycle. Vol. 1. Vienna; IAEA (1976).

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See CONF-760310—; STI/PUB—433(Vol.1).

Solvent degradation work at Harwell is described, including the identification of materials with very high metal retention properties and which appear to be long chain dialkyl phosphoric acids. Work on solid absorbents, for solvent clean-up, points to the possible use of an inorganic oxide as an alternative to the alkali wash. Destruction of tributyl phosphate by strong caustic soda produces aqueous dibutyl phosphate solution containing practically all the original radioactivity.

36968 Features of a process for vitrifying radioactive waste without precalcination and radionuclide behavior in the process. Konstantinovich, A.A.; Kulichenko, V.V.; Bel'tyukov, V.A.; Nikiforov, A.S.; Nikipelov, B.V.; Stepanov, S.E.; Baskov, L.I.; Kulakov, S.I. (Vsesoyuznyj Nauchno-Issledovatel'skij Inst. Neorganicheskikh Materialov, Moscow (USSR)). pp 385-394 of Management of radioactive wastes from the nuclear fuel cycle. Vol. 1. Vienna; IAEA (1976). (In Russian)

From IAEA symposium on the management of radioactive waste; Vienna, Austria (22 Mar 1976).

See CONF-760310—; STI/PUB—433(Vol.1).

The authors present the results of research and experimental work on the design of a facility for converting high-level waste into phosphate glass without preliminary drying and calcination. The technology of the process and the design of various items of the experimental facility are described. A lengthy period of operation has shown that the facility together with its gas purification system is functionally sound and can be recommended for trials with real high-level waste. The authors also present the results of investigations of the behaviour of radionuclides in the above process for producing phosphate glass in the experimental facility using sodium and aluminium nitrate and phosphoric acid solution simulating high-level waste. Operating conditions are developed which enable the amount of radionuclides incorporated in the glass to be increased. The trapping efficiency of radionuclides in the gas purification system is determined.

36969 Advances in techniques for bituminizing liquid waste from pressurized water nuclear power reactors. Lefillatre, G. (CEA Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-les-Durance (France)). pp 123-131 of Management of radioactive wastes from the nuclear fuel cycle. Vol. 2. Vienna; IAEA (1976). (In French)

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See CONF-760310—; STI/PUB—433(Vol.2).

The author gives an account of recent progress in the technique of direct bituminization (without preconcentration) of spent effluents from a nuclear power station with a light-water reactor (PWR). Direct bituminization involves complete dehydration in a vertical evaporator with a thin layer of dilute emulsion formed by the on-line mixing of bituminous emulsion and effluents at pH 9.6. The bituminized material containing 40 to 50% salts and less than 1% water flows by gravity into a drum, where it solidifies. There is complete decontamination of the distillates by passage over activated charcoal and ion-exchange resin columns. The process was developed at the pilot plant of the Cadarache Nuclear Research Centre, which is equipped with an LUWA L150 evaporator that can treat 60 l/h of effluents with an activity of the order of 1 Ci/m^3. The decontamination factors for the equipment range from 10^3 to 10^5, and the actual concentration factor attains 290 with effluents containing 2 g/l. The characteristics of the solidified waste, i.e. density, bitumen content, softening point, leaching rate, and thermal stability, are given. Finally, from the example of an industrial direct bituminization plant with a capacity of 3m^3/h, the author estimates the annual cost of treating spent effluents from two 900 MW(e) power plants (PWR) at 1.5 million francs. A comparison of a number of drums treated with bitumen and with cement suggests that, in terms of the solidified waste to be stored, there is a gain in volume of 2.7 in favour of bitumen.

36970 Sandia solidification process: a broad range aqueous waste solidification method. Lynch, R.W.; Dosch, R.G.; Kenna, B.T.; Johnstone, J.K.; Nowak, E.J. (Sandia Labs., Albuquerque, N.Mex. (USA)). pp 360-372 of Management of radioactive wastes from the nuclear fuel cycle. Vol. 1. Vienna; IAEA (1976).

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See CONF-760310—; STI/PUB—433(Vol.1).

New ion exchange materials of the hydrous oxide type were developed for solidifying aqueous radioactive wastes. These materials have the general formula M[M'sub(x)Osub(y)Hsub(z)]sub(n), where M is an exchangeable cation of charge +n and M' may be Ti, Nb, Zr, or Ta. Affinities for polyvalent cations were found to be very high and ion exchange capacities large, e.g. 4.0-4.5 meq/g for $NaTi_2O_5H$ depending on moisture content. The effectiveness of the exchangers for solidifying high-level waste resulting from reprocessing light-water reactor fuel was demonstrated in small-scale tests. Used in conjunction with anion exchange resin, these materials reduced test solution radioactivity from approximately 0.2 Ci/ml to as low as approximately 2 nCi/ml. The residual radioactivity was almost exclusively due to ^{106}Ru and total α-activity was only a few pCi/ml. Alternative methods of consolidating the solidified waste were evaluated using non-radioactive simulants. Best results were

obtained by pressure-sintering which yielded essentially fully dense ceramics, e.g. titanate/titania ceramics with bulk density as high as 4.7 g/cm^3, waste oxide content as high as 1.2 g/cm^3, and leach resistance comparable to good borosilicate glass. Based on the above results, a baseline process for solidifying high-level waste was defined and approximate economic analyses indicated costs were not prohibitive. Additional tests have demonstrated that, if desired, operating conditions could be modified to allow recovery of radiocaesium (and perhaps other isotopes) during solidification of the remaining constituents of high-level waste. Preliminary tests have also shown that these materials offer promise for treating tank-stored neutralized wastes.

36971 Preliminary experience with the new Harwell inactive vitrification pilot plant. Morris, J.B.; Chidley, B.E. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). pp 241-257 of Management of radioactive wastes from the nuclear fuel cycle. Vol. 1. Vienna; IAEA (1976).

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See CONF-760310—; STI/PUB—433(Vol.1).

The decision of the United Kingdom to adopt a policy of solidification of high level waste had led to renewed interest in vitrification. The HARVEST process chosen is an adaptation of the FINGAL concept developed at Harwell 15 years ago. Because of certain changes in engineering design and differences in the composition of the waste, additional chemical engineering data are required for HARVEST. The new inactive pilot plant has been built to provide this information. Its size is virtually full-scale and batches of glass up to 1 tonne can be manufactured in vessels of diameter up to 750mm. Five glass-making runs have been carried out. Attention has concentrated on the performance of the off-gas system which employs wet methods. Carry-over of solids occurs, primarily as a result of physical entrainment. The carry-over of synthetic fission products is improved from 2.5 to 0.1% by directing the feed down the vessel walls. Most of the entrained solids is caught in the condensate which gives no problems. However, some deposition has occurred in the off-gas pipe constituting a potential blockage problem. About 2% of a water-soluble yellow sulphate/molybdate/chromate solid is formed in vitrification. The sulphate (present as an impurity) accentuates the production of this phase and so its presence in high level waste should be avoided. The quality of the glass made in the pilot plant appears to be at least as good as laboratory samples.

36972 New techniques for the treatment of laundry and other low-level liquid wastes. Nakayama, Y.; Shirai, T. (Nippon Atomic Industry Group Co. Ltd., Kawasaki, Kanagawa. Nuclear Research Lab.); Hashimoto, H. (Tokyo Shibaura Electric Power Company, Tokyo, Japan); Kamiya, Y.; Sasaki, S. (Tokyo Electric Power Co., Inc. (Japan)); Kadoya, S.; Nomi, M.; Kawazu, H.; Sugimoto, S.; Sakaki, T. (Ebara Mfg. Co. Ltd., Tokyo (Japan)). pp 161-175 of Management of radioactive wastes from the nuclear fuel cycle. Vol. 1. Vienna; IAEA (1976).

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See CONF-760310—; STI/PUB—433(Vol.1).

The liquid wastes arising in BWR plants are generally classified under four types. Usually, three are reused as feed water after filtration, concentration and demineralization, while laundry liquid waste is discharged into the environment. Studies were made on laundry liquid waste treatment in order to establish a closed liquid waste system by using foamless detergent and evaporation treatment. It was demonstrated in pilot plant experiments that no foaming was caused during continuous concentration test runs from 500 to 200000 ppm. Then, the concentrated liquid was dried by LUWA wiped film vertical drier. The total volume reduction ratio through this concentration-drying system was calculated to be 1/2000. This treatment system may well be expected to have a potentiality of practical application in a few years to nuclear power plants in Japan. Although it is known that iron or iron compounds are effective in removing ruthenium, any satisfactory continuous treatment method of removing ruthenium present in minute quantities in the liquid waste has not yet been reported in the published literature. Based on the preliminary batch tests, column experiments using steel wool as the filter medium with activated surface layers produced by saturated steam were carried out mainly to develop a continuous method for industrial application. Some of the results of test runs made at a space velocity of $50m^3.m^{-3}.h^{-1}$, with ^{106}Ru spiked laboratory demineralized water clearly showed that the DFs of more than 100 were obtained even after treatment of the volume of liquid 10000 times the bed volume.

36973 Incorporation of radioactive wastes from nuclear power plants into concrete and bitumen. Peltonen, E.K.; Heinonen, J.U. (Valtion Teknillinen Tutkimuskeskus, Otaniemi (Finland). Reaktorilaboratorio); Kuusi, J. (Oy Finnatom Ab, Helsinki, Finland). pp 97-111 of Management of radioactive wastes from the nuclear fuel cycle. Vol. 2. Vienna; IAEA (1976).

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See CONF-760310—; STI/PUB—433(Vol.2).

On the basis of published data and mathematical calculations the study aims to critically review and assess in general the suitability of cementation and bituminization methods for the solidification of radioactive liquid wastes originating from nuclear power plant operation (i.e. excluding fuel reprocessing wastes). Particular endeavours were made on the grounds of the information gained to study and assess the applicability of these two techniques to wastes originating from the first Finnish power reactor VVER-440 in Loviisa. In evaluating the data obtained it turned out that solidification technology as a whole is still under development. There is an urgent need for the standardization of conceptions, terms, units and tests. The relevant properties of solidification products and their criteria should be clearly specified simultaneously considering further waste management steps, particularly final storage or disposal. In assessing the suitability of the two solidification techniques under Finnish circumstances it was stated that both cementation and bituminization would be applicable for the solidification of relevant wastes from the Loviisa plant. On the basis of data available one cannot definitively give either of the two techniques precedence. As regards the process, both techniques would be applicable with certain conditions. The solidified products do not show remarkable differences with respect to handling and transport. Under the conditions prevailing in Finland the space available for temporary storage on the plant site might play a comparatively important role, which will give precedence to the smaller amount of bituminized products, this being about one fifth of the equivalent concrete products.

36974 Research and development on removal of radioactive noble gases in Japan. Takashima, Y. (Tokyo Inst. of Tech. (Japan)); Segawa, T.; Tsutsumi, K. (Power Reactor and Nuclear Fuel Development Corp., Tokai, Ibaraki (Japan). Tokai Works); Yusa, H. (Hitachi Ltd., Ibaraki (Japan). Hitachi Research Lab.); Nishizawa, Y. (Mitsubishi Atomic Power Industries, Inc., Omiya, Saitama, Japan); Ohno, M. (Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa (Japan). Research and Development Center). pp 115-126 of Management of radioactive wastes from the nuclear fuel cycle. Vol. 1. Vienna; IAEA (1976).

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See CONF-760310—; STI/PUB—433(Vol.1).

Various methods of removing noble gases from contaminated gas streams have been investigated by several groups for some years in Japan. A cryogenic distillation process is now being applied to the reprocessing plant as a result of fundamental studies and subsequent pilot-plant experiments. Three types of selective membrane processes, which differ somewhat depending upon the nature of the contaminated gas, have been developed. The first, for treating the exhaust gas from the PWR, employs a palladium alloy film. The second, composed of a cascade of porous membranes similar to those used for gas diffusion, shows a fairly good separation performance and may be practicable on a moderate scale. The third, in which a pair of fibrous bundles of porous membranes and homogeneous membranes are used as a unit separator and make the gas handling simpler, also shows very interesting separation characteristics. A cryogenic adsorption method for off-gas treatment from the BWR has been successfully developed with three subsystems, namely the enrichment of noble gases, the removal of O_2, O_3 and NOsub(x) and the storage of enriched noble gases. A separation process by a cascade of thermal diffusion columns seems to be applicable for clean-up of Ar cover gas on the surface of Na coolant in the FBR.

36975 Actinide partitioning. Arguments against. Verkerk, B. (Stichting Reactor Centrum Nederland, Petten). pp 225-230 of Management of radioactive wastes from the nuclear fuel cycle. Vol. 2. Vienna; IAEA (1976).

From IAEA symposium on the management of radioactive waste; Vienna, Austria (22 Mar 1976).

See CONF-760310—; STI/PUB—433(Vol.2).

The need for actinide partitioning is discussed on the basis of the radiotoxic hazard measure, the safety of disposal in a salt formation and the evaluation of the risk of 1000 year old high-level waste glass for the case of 100% availability for intake. It is shown that aged waste is a substance of only limited toxicity. This fact is the main argument to conclude that, except for the usual recovery of plutonium, we should not take the trouble to separate the actinides from fission products for the purpose of decreasing the long-term hazard of reprocessing waste.

36976 Integrated system for the conditioning of radioactive solid wastes and liquid waste concentrates. van de Voorde, N.; Dumont, G.; Claes, J.; Taeymans, A.; Vangeel, J.; Dejonghe, P. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). pp 141-152 of Management of radioactive wastes from thenuclear fuel cycle. Vol. 1. Vienna; IAEA (1976).

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From IAEA symposium on the management of radioactive waste; Vienna, Austria (22 Mar 1976).

See CONF-760310—; STI/PUB—433(Vol.1).

Up to now, concentrates resulting from the treatment of the relatively large quantities of low-level radioactive wastes have been mostly conditioned with concrete or bitumen. There is, however, a certain incentive to improve the long-term stability of conditioned concentrates as well as their resistivity against fire, especially when small amounts of plutonium are present. In the laboratories of the Nuclear Energy Research Establishment (SCK/CEN) at Mol, an integrated treatment and insolubilization system is being developed for the processing of most low-level radioactive solid wastes and concentrates arising from the treatment of most gaseous and liquid effluents. The main part of the process consists of a high temperature flash incineration (at 1500 to 1600°C) of a mixture containing the combustible and some of the incombustible waste and concentrates such as chemical sludges, ion exchangers etc., producing a highly insoluble, basaltic slag. The pilot plant and the first operational experiences are described in the paper.

36977 Experimental facilities for the development of the United Kingdom high-level liquid solidification process. Warner, B.F.; Larkin, M.J.; Taylor, R.J.; Lowes, L. (British Nuclear Fuels Ltd., Sellafield); Johnson, S.N. (British Nuclear Fuels Ltd., Risley). pp 231-239 of Management of radioactive wastes from thenuclear fuel cycle. Vol. 1. Vienna; IAEA (1976).

From IAEA symposium on the management of radioactive waste; Vienna, Austria (22 Mar 1976).

See CONF-760310—; STI/PUB—433(Vol.1).

The development required before committing a vitrification plant to active operation is discussed, and the objectives of the development programme defined. A description is given of the major new facilities planned in the United Kingdom - a plant for making kilogram-scale blocks of glass from actual high-level wastes; a facility for the detailed examination of the glass produced in this plant; and a full-scale inactive replica of the production plant. The purpose of each of these facilities is discussed.

36978 Properties of phosphate and silicate glasses used for the solidification of radioactive waste. Brezhneva, N.E.; Oziraner, S.N.; Minaev, A.A.; Kuznetsov, D.G. (AN SSSR, Moscow. Inst. Fizicheskoj Khimii). pp 85-94 of Management of radioactive wastes from the nuclear fuel cycle. Vol. 2. Vienna; IAEA (1976). (In Russian)

From IAEA symposium on the management of radioactive waste; Vienna, Austria (22 Mar 1976).

See CONF-760310—; STI/PUB—433(Vol.2).

The authors study the chemical and thermal stability of phosphate and borosilicate glasses intended for fixing radioactive waste containing sodium and aluminium salts. Vitrification regions in the systems Na_2O - Al_2O_3 - P_2O_5 and Na_2O - Al_2O_3 - CaO - B_2O_3 - SiO_2 are investigated together with some of the properties of the glasses themselves, such as chemical stability, softening point and the temperature at which crystallization begins. It is demonstrated that these systems can yield chemically and thermally stable glasses capable of fixing up to 50% radioactive waste (as calcined residue).

36979 (ORNL-tr—4599) **Statedment of low- and medium-activity waste solutions from reprocessing plants.** Kahl, L.; Bahr, W.; Eden, G.; Kelm, M.; Drobnik, S. [nd]. Translation by S.D. Blalock, Jr. of pp 142-149 from KFK—2380. 7p. Dep. NTIS, PC A02/MF A01.

A design was worked out for the treatment of medium-activity waste solutions which aims at reducing the vast quantities and improving the quality of the end products. The procedure provides for a reduction in transported salts from the waste solutions by denitrating the nitric acid with formic acid and the separation of up to at least 99 percent of the fission products, actinide elements and corrosion products from the denitrated solutions by coprecipitation and adsorption on vitrifiers. The resulting smaller quantity of higher-activity residue can be either added to the highly-active wastes (HAW) and vitrified or directly vitrified by themselves. The low-activity, high-salt filtrate can finally be embedded in bitumen without ever reaching a radioactivity limit.

WASTE DISPOSAL AND STORAGE

REFER ALSO TO CITATION(S) 36951, 36975, 37005

36980 (BNL—50728) **Tritium storage development. Progress report No. 10, October—December 1976.** Colombo, P.; Steinberg, M. (Brookhaven National Lab., Upton, N.Y. (USA)). 1976. Contract EY-76-C-02-0016. 22p. Dep. NTIS, PC A02/MF A01.

Laboratory and engineering scale work has been initiated on the storage of tritium in a metal hydride. Laboratory hydriding apparatus has been assembled and a preliminary series of experiments was carried out on zirconium. Several engineering design concepts for the reaction and storage of tritium in a metal hydride are presented. The design of a three 3-in.-diam. bench scale reaction system is in progress. Developmental work is continuing on the injector technique for the fixation of tritium in polymer-impregnated concrete.

36981 (CONF-770440—, pp 283) **Underground storage of radioactive waste material in non-saline rock masses.** Witherspoon, P.A.; Gale, J.E. (Univ. of California, Berkeley). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977). In Energy and mineral resource recovery.

One potential alternative for terminal storage of radioactive waste is the utilization of mined caverns in argillaceous and crystalline rock masses. The success of this approach depends on keeping the radioactive materials from returning to the biosphere under very long periods of time. In a properly selected site the porosity and permeability of intack rock should be so small that no appreciable movement through such a pathway will be possible. Thus, the only way in which radioactive material can reach the biosphere is through fractures (faults, shears, joints and solution channels) in the rock mass. One must, therefore, be able to define the factors that control the flow of fluids through such discontinuities in rock masses. Recent studies of underground mines and excavations in igneous and metamorphic rocks have shown that, while ground water inflow occurs along joints and faults to depths of 300 meters, inflows decrease with depth and in nearly all cases no inflows were observed below 1,000 meters. These studies have shown that there is a complex relationship between mine depth, character and degree of interconnection of fracture systems, mining history and ground water inflow. Current laboratory and field data on flow and fractured media will be discussed with reference to the storage of radioactive waste material.

36982 (CONF-770847—6) **Thermal responses in underground experiments in a dome salt formation.** Llewellyn, G.H. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 12p. Dep. NTIS, PC A02/MF A01.

From 15. international thermal conductivity conference; Ottawa, Ontario, Canada (24 Aug 1977).

To provide design information for a radwaste repository in dome salt, in-situ experiments with nonradioactive heat sources are planned. Three such experiments using electrical heat sources are scheduled to be carried out in a salt dome. The purpose of these experiments is to acquire rock mechanics data to ascertain the structural deformation due to the thermal load imposed, to study brine migration and corrosion, and to provide thermal data. A data acquisition system is provided with these experiments to monitor temperatues, heat fluxes, stresses, and ground displacement. A thermal analysis was made on models of each of these experiments. The objective of the analysis is to verify the capability of making accurate transient temperature predictions by the use of computer modeling techniques. Another purpose is to measure in-situ thermal conductivity and compare the results with measurements taken from core samples. The HEATING5 computer program was used to predict transient temperatures around the experiments for periods up to 2 years using two-dimensional and three-dimensional heat transfer models. The results of analysis are presented with the associated boundary conditions used in the individual models.

36983 (MLM—2489) **Acceptable TRU packaging for interim storage and/or terminal isolation: FY-1977 final report.** Doty, J.W.; Peterson, J.B. (Mound Facility, Miamisburg, Ohio (USA)). 17 Feb 1978. Contract EY-76-C-04-0053. 34p. Dep. NTIS, PC A03/MF A01.

A program was conducted for the definition and demonstration of acceptable waste packages for defense transuranic waste for interim storage and terminal isolation. During FY-1977, a Contractor Questionnaire was used to gather pertinent data and to assess contractor concerns. This information was integrated into basic application data in the form of a checklist. Conceptual Container Design Specifications were developed by analyzing and evaluating the application data against Federal Regulations and interim/terminal storage constraints.

36984 (SAND—77-0752) **Application of thermal conduction models to deepsea disposal of radioacitve wastes.** Schimmel, W.P. Jr.; Hickox, C.E. (Sandia Labs., Albuquerque, N.Mex. (USA)). Mar 1978. Contract EY-76-C-4-0789. 46p. Dep. NTIS, PC A03/MF A01.

Thermal problems associated with the emplacement of radioactive wastes in the deepsea sedimentary layer have been studied. In particular, the nature of the temperature field surrounding and the interstitial water velocity arising from a buried cask have been examined. Worst case estimates indicate that the velocity will be extremely weak and thus not likely to provide a primary transport mechanism for the radioactive material. This statement will, of course, only apply for moderately low levels of heat generation by the decaying radio nuclides. Because of the low interstitial water velocity, thermal conduction models can be used to predict the

temperature field in the surrounding sediments as well as the cask surface temperature. This is equivalent to "decoupling" the energy and momentum conservation relationships thus simplifying the solution of the temperature field. The present work considers in come detail the temperature field surrounding a vertical circular "cylinder" located a distance below a horizontal, isothermal, plane surface. Actually, the isotherm corresponding to the cask surface is an ellipsoid of revolution but the error will be small for large values of the length to diameter ratio. The resulting expression can be usd to estimate temperature of the cask surface for material degradation studies and the effect of temperature upon the ion transport process in the sediments.

36985 (SAND—78-0714C) **Development of risk assessment methodology applicable to radioactive waste isolation.** Campbell, J.E.; McGrath, P.E.; Cullingford, M.C. (Sandia Labs., Albuquerque, N.Mex. (USA); Nuclear Regulatory Commission, Washington, D.C. (USA)). 1978. Contract EY-76-C-04-0789. 16p. (CONF-780507—11). Dep. NTIS, PC A02/MF A01.

From Probabilistic analysis of nuclear reactor safety; Los Angeles, CA, USA (8 May 1978).

Portions of document are illegible.

The risk from radioactive waste disposal in a deep geologic formation has not yet been completely assessed. A complete assessment should include credible estimates of the likelihood that radioactive materials would escape the repository and enter the human environment, and the magnitude of the resultant consequences in terms of human health effects. In addition, such an assessment should identify the dominant contributors to risk and, to the extent possible, quantify the uncertainties in risk estimates. A complete risk assessment may not be possible because of our limited knowledge of various aspects of geology and hydrogeology important to the long-term safety of a radioactive waste repository. The results of past analyses are not entirely consistent, perhaps as a direct result of the limited knowledge of the phenomena involved. It may, therefore, seem premature to attempt a rigorous risk analysis of radioactive waste disposal in deep, geologic media at the present time. However, the value of such analyses lies more in the insight and information they provide than in their prediction of absolute levels of risk.

36986 (UCRL—50050-77) **Waste isolation projects, FY 1977.** Ramspott, L.D. (ed.). (California Univ., Livermore (USA). Lawrence Livermore Lab.). 18 Jan 1978. Contract W-7405-ENG-48. 28p. Dep. NTIS, PC A03/MF A01.

The technology and data base required to license a nuclear repository in a crystalline rock medium, located at or near the Nevada Test Site are being developed. The program consists of three related project areas: field and laboratory studies of the availability and migration of radionuclides in ground water; thermomechanical response of granite, through heater tests at the Climax stock of the Nevada Test Site; and laboratory measurements of physical properties of rocks at elevated temperatures and pressures, including physical/chemical factors that inhibit water transport in deep silicate rocks. Work accomplished in these areas is report. (LK)

36987 (UCRL—52000-77-10, pp 9-17) **Devloping criteria for the management of nuclear wastes.** Heckman, R.A. Oct 1977.

In Energy and technology review.

As highly radioactive wastes continue to accumulate from both commercial and military reactors, the problem of disposal systems and permanent storage sites becomes ever more pressing. We are studying this problem to provide the Nuclear Regulatory Commission with a firm technical basis for its decisions in setting up regulations and guidelines for the management of nuclear wastes and for the licensing of reprocessing and storage facilities. This study has developed the mathematics for comprehensive and systematic modeling of complete nuclear waste disposal scenarios. For the widely accepted waste disposal scheme of deep burial, our research suggests that transportation to the disposal site is potentially the most hazardous aspect. Our work has also indicated several performance criteria that would greatly decrease the risk.

36988 (Y/OWI/TM—45/3) **Office of Waste Isolation progress report, December 1976.** (Union Carbide Corp., Oak Ridge, Tenn. (USA). Office of Waste Isolation). 18 Jan 1977. Contract W-7405-ENG-26. 48p. Dep. NTIS, PC A03/MF A01.

Status of the following studies is reported: volcanic rocks, crystalline rocks, Pierre shale, Elena Formation, heat transfer/thermal analysis, waste/rock interaction, rock mechanics, borehole plugging, and shale and clay mineral studies. Facility projects reported on include shale in situ tests, dome salt in situ tests, canister transporter studies. Systems projects reported on include schedule and control systems development, waste canister envelope study, transportation/logistics study, and spent fuel study. (LK)

36989 (Y/OWI/TM—45/12) **National waste terminal storage program. Progress report, September 1977.** Asher, J.M. (ed.). (Union Carbide Corp., Oak Ridge, Tenn. (USA). Office of Waste Isolation). 19 Oct 1977. Contract W-7405-ENG-26. 72p. Dep. NTIS, PC A04/MF A01.

Project reports are given of the following studies: USGS Water Resources Division study of Louisiana salt domes; Northeast Texas Salt Dome Basin study; salt-dome hydrology in Mississippi; volcanic rocks; crystalline rocks; Paradox Basin; geologic studies at the Nevada Test Site; heat transfer/thermal analysis; waste/rock interaction; rock mechanics; borehole plugging; safety and reliability; shale and clay mineral studies; conceptual design of NWTS repositories; waste container studies; transportation/logistics study; and environmental study. (LK)

36990 **Nuclear waste disposal: can the geologist guarantee isolation.** de Marsily, G. (Ecole Nationale Superieure des Mines de Paris, Fontainebleau, France); Ledoux, E.; Barbreau, A.; Margat, J. *Science;* **197**: No. 4303, 519-527(5 Aug 1977).

The confining power of deep geological formations over very long time periods is discussed for highly toxic radionuclides with long half-lives (^{129}I, ^{237}Np, ^{239}Pu). Parameters governing the possible mechanisms of radionuclide migration are described. The Oklo phenomenon is considered as an example of geological confinement in nature. If the integrity of the glass matrix of the waste cannot be guaranteed for millions of years, highly adsorbed elements such as Pu can be retained if the geological environs and the ionic form of the radionuclide are favorable. A geologic formation should not be considered as a confining barrier for long-lived radionuclides for which it has no ion exchange capacity, if ground water can reach the waste or if a hydraulic gradient exists. The confinement could be reinforeced locally by means of a complementary physical barrier. 31 refs, 5 tables, 1 fig. (DLC)

36991 **Radioactive wastes.** Straub, C.P. (Univ. of Minnesota, Minneapolis). *J. Water Pollut. Control Fed.;* **49**: No. 6, 1192-1199(Jun 1977).

A review is presented of the treatment, storage, fixation and disposal of radioactive wastes. Various methods are described for extracting and separating the radionuclides, for example ^{134}Cs, ^{137}Cs, ^{204}Tl and ^{60}Co ions were simultaneously deactivated on natural sorbents by precipitation reactions. For long term storage, wastes should be solidified and immobilized to ensure containment, reduce surveillance, and reduce the need for replacement of storage facilities. The use of argillaceous formations as host rocks for underground emplacement of radioactive wastes is outlined. For the fixation process, the use of bitumenization for low and medium radioactive wastes is described, as well as methods for fixing aqueous tritiated wastes in concrete, and the application of ion-exchange materials of the hydrous oxide type to solidify aqueous radioactive wastes. Both ground disposal and sea disposal are discussed. The legal background for disposal of radioactive wastes into coastal waters is mentioned, also the rules developed by the Nuclear Energy Agency related to design and construction of waste containers, choice of appropriate ships, and radiological safety of the crew.

36992 **Radioactive waste package development at the Rocky Flats Plant.** Merlini, R.J.; Cash, D.L.; Terada, K. (Atomics International Div., Golden, Colo. (USA). Rocky Flats Plant). pp 153-160 of Transport packaging for radioactive materials. Vienna; IAEA (1976).

From Symposium on the design, construction and testing of packaging for the safe transport of radioactive materials; Vienna, Austria (23 Aug 1976).

See CONF-760813—.

Information is presented on some of the historical and current package developments for the plutonium-239 wastes generated at the Rocky Flats Plant. The two basic packages used for waste containment during transportation and storage are the steel drum and the plywood box. For steel drums, a discussion on a series of liners and liner characteristics designed to provide long package life is presented. This discussion includes data on the liner specifications, materials of construction, sealing techniques, seal strengths, and drop tests. For the plywood box, some experience and developments are described on the design, construction and drop testing of boxes coated with fiberglass reinforced plastic (FRP). Cost data and comparisons as appropriate for different drum liners and for the FRP coated plywood box are also included. The Rocky Flats facility is operated by Rockwell International, Atomics International Division, for the United States Energy Research and Development Administration (U.S. ERDA).

36993 **Problems in the design and specification of containers for vitrified high-level liquid waste.** Corbet, A.D.W.; Hall, G.G.; Spiller, G.T. (British Nuclear Fuels Ltd., Risley). pp 217-230 of Management of radioactive wastes from the nuclear fuel cycle. Vol. 1. Vienna; IAEA (1976).

From IAEA symposium on the management of radioactive waste; Vienna, Austria (22 Mar 1976).

See CONF-760310—; STI/PUB—433(Vol.1).

In the United Kingdom the growing problem of ensuring the safe storage of high-level liquid waste over long time scales has led to a policy for implementing solidification. A brief description is given of the HARVEST vitrification process, which is essentially a scaled-up version of the FINGAL process with increased throughput. The functional requirements of the container are considered. It must be made of a material which can be fabricated to a high standard. Diameters up to 600 mm for right circular cylindrical containers and 1200 mm for annular containers are contemplated. Computer aids for axisymmetric and three-dimensional heat transfer and stress analysis are identified. One example is given of the thermal profile for the cylindrical container in the furnace and another example for the annular container following an accident condition. Measured values are given for high temperature oxidation, emissivity and the short-term creep strength of various alloys. Corrosion in fresh water and sea water over long time periods and leaching of partially exposed solid waste are discussed and a conceptual package for sea bed disposal is described. The relative merits of the different methods of manufacture are pointed out and the paper concludes that HK-40 or better INCOLOY alloy 800L are suitable materials of construction.

36994 Engineered storage for the disposal of non-fuel bearing components from nuclear facilities and general radioactive waste. Andrews, L.J. (Chem-Nuclear Systems Inc., Bellevue, Wash., USA). pp 373-382 of Management of radioactive wastes from thenuclear fuel cycle. Vol. 2. Vienna; IAEA (1976).

From IAEA symposium on the management of radioactive waste; Vienna, Austria (22 Mar 1976).

See CONF-760310—; STI/PUB—433(Vol.2).

Non-Fuel Bearing Component (NFBC) waste from nuclear facilities is not a voluminous waste; however, for a commercial burial site, it is a much more hazardous waste by nature of the significantly higher radiation levels. Burial is presently done in excavated slit trenches and a modified form is in use at the CNSI Barnwell facility. This disposal technique creates considerable problems in the handling efficiency, site utilization and personnel exposure. An engineered transport and burial system to reduce the problems and the exposure are discussed. Currently, non-fuel bearing components and irradiated hardware coming from the reactor core are sheared, crushed, containerized and transported to the waste burial site in a top-loading and top-unloading transport cask. At the site, this cask must be removed from the trailer and placed in a vertical position to remove the waste container. The process of removing a highly radioactive container from the cask with site equipment, in the open air, and transferring this container to a slit trench, creates handling problems and excessive exposure. A top-loading bottom-unloading transport cask and trailer unit has been designed so that in combination with an engineered waste disposal will simplify handling, minimize exposure, maximize site utilization and reduce burial site selection problems. The integrated technique discussed sets forth the interfaces, the logic of the transport device, the canister transfer from the cask to the disposal sleeve in a concrete vault with minimal exposure to personnel. Site utilization, cask handling efficiency and exposure control is the motivation for this presentation.

36995 Disposal of long-lived radioactive wastes in Italy. Gera, F.; Lenzi, G.; Sensi, L. (Comitato Nazionale per l'Energia Nucleare, Casaccia (Italy). Centro di Studi Nucleari); Cassano, G. (Comitato Nazionale per l'Energia Nucleare, Policoro (Italy). Centro Nucleare della Trisaia). pp 259-269 of Management of radioactive wastes from the nuclear fuel cycle. Vol. 2. Vienna; IAEA (1976).

From IAEA symposium on the management of radioactive waste; Vienna, Austria (22 Mar 1976).

See CONF-760310—; STI/PUB—4233(Vol.2).

The CRN Trisaia, located in Basilicata in Southern Italy, is the reference site for CNEN's research and development programme on disposal of long-lived radioactive wastes in clay formations. The Trisaia Centre is in an area characterized by relative tectonic stability, despite its proximity to the Apennine orogen. The site is located a few kilometres from the Ionian Sea on a Quaternary terrace, a few metres above the elevation of the coastal plain. The terrace materials, which are mainly sand, gravel and conglomerate, are underlain by 800 to 1000m of marly clays. Some sand lenses are contained in the clay formation nearby the site, particularly between 350 and 500m in depth; however, thick sections of homogeneous clays have been crossed by all exploratory bore-holes drilled in the area. The marly clays are Plio-Pleistocene and contain about 70% clay minerals and about 20% calcium carbonate. Their colour is blue-gray at depth, while at the surface they are yellow as a result of weathering. The permeability is of the order of 10^{-8}cm/s. A heating experiment was performed with an electrical heater placed at a depth of 8m. However, the results are somewhat questionable due to the defective plugging of the holes where the heater and the thermocouples were positioned. A second heating experiment is now planned; it should employ three heaters at a somewhat greater depth; both pressures and temperatures will be measured. Many additional geological, engineering and safety studies are planned on the Trisaia clay formation.

36996 Waterproof geometry of salt domes, an important safety aspect for their exploitation for ultimate disposal of high-level waste. Hamstra, J. (Stichting Reactor Centrum Nederland, Petten). pp 295-301 of Management of radioactive wastes from the nuclear fuel cycle. Vol. 2. Vienna; IAEA (1976).

From IAEA symposium on the management of radioactive waste; Vienna, Austria (22 Mar 1976).

See CONF-760310—; STI/PUB—433(Vol.2).

Salt domes used as possible containment structures for radioactive waste repositories can only fail in the long term through the continuous action of groundwater. The potential failure mechanism will not be the groundwater penetrating into the repository area, as long as the salt dome still remains in contact with its salt matrix. The buoyant force of the sediments overlying and surrounding the salt dome will, under certain stress conditions, enable salt to migrate towards the dissolving surface at such a rate that the salt dome will maintain its piercement shape, notwithstanding the continuing dissolving action. If this salt migration should prove to be a containment failure mechanism, it may only affect the waste repository to a limited extent and after a very long period of time. Model studies might reveal whether it is still realistic to adapt the layout of the waste repositories inside salt domes to the salt migration pathways.

36997 Investigations into the possibility of final disposal of radioactive wastes in an underground clay formation. Heremans, R.; Dejonghe, P.; Willocx, J. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)); Gulinck, M.; Laga, P. (Service geologique de Belgique, Bruxelles, Belgium). pp 245-257 of Management of radioactive wastes from the nuclear fuel cycle. Vol. 2. Vienna; IAEA (1976). (In French)

From IAEA symposium on the management of radioactive waste; Vienna, Austria (22 Mar 1976).

See CONF-760310—; STI/PUB—433(Vol. 2).

The final disposal of long-lived and very long-lived radioactive waste is a problem that will have to be solved within the next few decades. One possible solution is to bury the solidified waste in a carefully chosen geological formation. With this purpose in mind, the Nuclear Research Centre has begun a research and development programme aimed at evaluating the suitability of a clay bed situated in the Campine region of Belgium. The paper briefly describes the general geological and hydrogeological aspects of a site selected in the region of Mol, where the Centre is located. In addition to the initial results of field experiments, it also reports on laboratory analyses and tests of the chemical and mineralogical compositions, and likewise on the mechanical properties and ion-exchange capacity of clay collected during geological drilling. The work at present under way should provide a set of scientific data that will assist in assessing the validity of this solution to the problem of the final disposal of solidified radioactive wastes.

36998 Recent results and developments on the disposal of radioactive wastes in the Asse Salt Mine. Kuehn, K.; Albrecht, E.; Kolditz, H.; Thielemann, K. (Gesellschaft fuer Strahlen- und Umweltforschung m.b.H., Clausthal-Zellerfeld (Germany, F.R.). Inst. fuer Tieflagerung); Diefenbacher, W.; Engelmann, W.J.; Krause, H.; Schuchardt, M.C.; Smailos, E. (Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (Germany, F.R.)). pp 287-293 of Management of radioactive wastes from the nuclear fuel cycle. Vol. 2. Vienna; IAEA (1976).

From IAEA symposium on the management of radioactive waste; Vienna, Austria (22 Mar 1976).

See CONF-760310—; STI/PUB—433(Vol.2).

Disposal of radioactive wastes into rock salt formations has been pursued in the Federal Republic of Germany since 1963. The Asse Salt Mine serves as the national R and D facility. 62000 containers with low-level wastes were disposed of from April 1967 till February 1976. In addition, 746 drums with intermediate-level wastes found their final place in the mine. Both disposal techniques are under continuous development. One further R and D project is at present under construction, while a second one is in the planning phase. The Asse prototype cavity will test the possibility of direct disposal of intermediate-level wastes without shielding through a small diameter shaft into a cavity. This project will start operation in early 1979. Within the same time all necessary investigations and developments will be performed in order to start a test disposal operation with solidified high-level wastes in the early eighties.

36999 Developments and studies for marine disposal of radioactive wastes. Machida, C.; Ito, A. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment); Matsumoto, A. (Japan Atomic Energy Research Inst., Oarai, Ibaraki. Oarai Research Establishment); Sakata, S. (Japan Atomic Energy Research Inst., Tokyo); Nagakura, T.; Abe, H. (Central Research Institute of Electric Power Industry, Civil Engineering Lab., Abiko City, Chiba,

Japan). pp 339-346 of Management of radioactive wastes from the nuclear fuel cycle. Vol. 2. Vienna; IAEA (1976).

From IAEA symposium on the management of radioactive waste; Vienna, Austria (22 Mar 1976).

See CONF-760310—; STI/PUB—433(Vol.2).

Before realization of experimental sea-dumping operations expected to start in 1977, considerable tasks have been undertaken in various fields related to low-level radioactive wastes and promising areas in the Pacific. The main effort is being put on high performance treatments to reduce the amount to be dumped and demonstrating the integrity of the waste packages. Bituminization and incineration are the preferred processes from the standpoint of reducing the amount. Several developments and improvements to these processes are being explored. A cement solidification method has been utilized to prepare the waste packages from nuclear power stations. To establish provisional guidelines, cement-solidified packages have been examined for their integrity under high hydrostatic pressure tests and free fall tests. Multistage packages have also been investigated. Radioactivity leachability into the aqueous phase is one of the important indices in evaluating package design and specifications. Leaching of solidified radionuclides under normal and higher pressures has been studied on small specimens and full-scale packages.

37000 Canadian program for storage and disposal of spent fuel and high-level wastes. Mayman, S.A. (Atomic Energy of Canada Ltd., Pinawa, Manitoba. Whiteshell Nuclear Research Establishment); Barnes, R.W. (Ontario Hydro, Toronto (Canada)); Gale, J.E.; Sanford, B.V. (Geological Survey of Canada, Ottawa, Ontario). pp 49-56 of Management of radioactive wastes from the nuclear fuel cycle. Vol. 1. Vienna; IAEA (1976).

From IAEA symposium on the management of radioactive waste; Vienna, Austria (22 Mar 1976).

See CONF-760310—; STI/PUB—433(Vol.1).

Spent fuel from Canadian reactors is presently stored at the reactor sites, in water filled bays. However, Ontario Hydro is planning to have a central fuel storage facility in operation by 1985. One water cooled and two air cooled concepts are being considered for use at this facility. One of the air cooled concepts - the concrete canister - is being tested by Atomic Energy of Canada Limited, and results to date are encouraging. Methods for disposal of high-level wastes from reprocessing plants are being developed as well. A mined cavity in plutonic crystalline rock is favoured, but salt is a strong candidate and the Geological Survey of Canada is carefully evaluating all Canadian salt deposits. A small study in serpentinite is also in progress. A geologic disposal facility is expected to be available for commissioning and test emplacements by 1985. By the year 2000 it could be licensed to accept wastes on a routine production basis. This timing is compatible with the requirements of the Canadian nuclear industry.

37001 Leaching of radioactivity from highly radioactive glass blocks buried below the water table: Fifteen years of results. Merritt, W.F. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). pp 27-34 of Management of radioactive wastes from the nuclear fuel cycle. Vol. 2. Vienna; IAEA (1976).

From IAEA symposium on the management of radioactive waste; Vienna, Austria (22 Mar 1976).

See CONF-760310—; STI/PUB—433(Vol.2).

The results from two test burials of high-level fission products incorporated into nepheline syenite glass indicate that the nuclear wastes from fuel processing for a 30000 MW(e) nuclear power industry coud be incorporated into such glass and stored beneath the water table in the waste management area of Chalk River Nuclear Laboratories (CRNL) without harm to the environment.

37002 Recent experience with the land burial of solid low-level radioactive wastes. Meyer, G.L. (Environmental Protection Agency, Washington, D.C. (USA). Office of Radiation Programs). pp 383-394 of Management of radioactive wastes from the nuclear fuel cycle. Vol. 2. Vienna; IAEA (1976).

From IAEA symposium on the management of radioactive waste; Vienna, Austria (22 Mar 1976).

See CONF-760310—; STI/PUB—433(Vol.2).

Low-level, nuclear fuel cycle wastes are being disposed of at six commercially operated sites in the United States of America. Similar wastes resulting from Federal activities are being disposed of at five Federally operated sites. The hydrology, geology, climate and operational practices at these sites vary greatly. At three sites in the wetter eastern United States which have low-permeability burial media, it is difficult to keep water from getting into the trenches. Two commercial burial sites in New York and Kentucky have not performed as planned. Authorization to operate these facilities was based on site analyses which, it was believed, demonstrated that the buried radioactive wastes would not migrate from the site during their hazardous lifetime (i.e. for hundreds of years). In ten years or less, however, radioactivity has been detected offsite from these two sites. Radioactivity has migrated offsite from the Federal burial site at Oak Ridge National Laboratory, also. State and Federal authorities have stated that the radioactivity in the environment around the site was not a health hazard at this time. Information is presented on recent disposal practices and experience at these three low-level burial facilities. Based on this experience, the paper (1) briefly describes operations and problems at the sites; (2) suggests factors which led to the problems; (3) identifies problems which appear to be generic to disposal in humid climates; (4) identifies specific problems which could either reduce the ability to predict the impact of disposal operations or reduce the retention capability of the site; and (5) recommends improvements which can be made in site selection, development, and operation to reduce the environmental impact of the site.

37003 Disposal of radioactive wastes produced in nuclear installations in the German Democratic Republic. Richter, D.; Koerner, W. (Staatliches Amt fuer Atomsicherheit und Strahlenschutz, Berlin (German Democratic Republic)). pp 271-285 of Management of radioactive wastes frm the nuclear fuel cycle. Vol. 2. Vienna; IAEA (1976).

From IAEA symposium on the management of radioactive waste; Vienna, Austria (22 Mar 1976).

See CONF-760310—; STI/PUB—433(Vol.2).

Studies on methods for the disposal of radioactive wastes applicable to the territory of the German Democratic Republic were made in connection with the prospective use of nuclear power. The investigations included the following methods: storage above ground or immediately below ground level, storage in salt formations and mine galleries, and injection into porous subsurface rock. From a comparison of the economic and nuclear-safety aspects of various variants it follows that the secondary use of an abandoned salt mine as central repository for radioactive wastes represents a favourable and prospective solution for the GDR over the next decades. At present the central repository is under construction. It was subjected to a thorough safety assessment according to the regulations on the licensing of nuclear installations in the GDR.

37004 (ORNL-tr—4600) **Conditions for the storage of weakly radioactive wastes in the Asse salt mine.** Bechthold, W.; Diefenbacher, W. 1975. Translation of pp 204-208 from KFK—2380. 5p. Dep. NTIS, PC A02/MF A01.

Changes in the conditions are listed. They cover containers for storage and permissible radioactivity per container for 3 waste categories. (DLC)

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 36990, 37756, 37953, 37997, 38239

37005 (CONF-780304—9) **Assessment of the loss of radioactive isotopes from solidified wastes.** Godbee, H.W.; Kibbey, A.H.; Joy, D.S. (Oak Ridge National Lab., Tenn. (USA)). 1978. Contract W-7405-ENG-26. 9p. Dep. NTIS, PC A02/MF A01.

From ANS - The Back End of the LWR Fuel Cycle; Savannah, GA, USA (19 Mar 1978).

Amounts of ^{137}Cs and ^{239}Pu entering the environment by leaching of grout products are predicted as functions of time, considering a 55-gal drum as a finite source and as a semi-infinite medium with and without decay. Significant differences between finite-cylinder and semi-infinite-medium calculations appear after a few years of leaching when the effective diffusivity (D) is 1.2×10^{-9} cm^2/s, but do not appear up to 3,000 years when D is 6.0×10^{-16} cm^2/s. The smaller D is and the larger the size is, the longer a finite specimen will behave as a semi-infinite medium. (DLC)

37006 (DOCKET-408584—1) **Sweetwater Uranium Project. Draft environmental statement.** (Nuclear Regulatory Commission, Washington, D.C. (USA). Office of Nuclear Material Safety and Safeguards). Dec 1977. 197p. (NUREG—0403(Draft)). Dep. NTIS, PC A09/MF A01.

The proposed action is the issuance of a Source Material License to Minerals Exploration Company for the construction and operation of the proposed Sweetwater Uranium Mill with a nominal capacity of 3000 tons (2.7×10^6 kg) per day of uranium ore in Wyoming. The applicant proposes also to construct a heap-leaching and resin ion-exchange facility to extract uranium from low-grade ores and mine water. Impacts to the area due to the operation of the Sweetwater Uranium Mine/Mill Project will result in: Alternations of up to 2200 acres by the mill, mine pit area, and roads, and about 3450 acres of Battle Spring Flat to be inundated by mine dewatering operations; increase in the existing background radiation levels; socioeconomic effects on Rawlins and other nearby areas; and tailings from the mill will be produced at a rate of about 3000 tons (2.7×10^6 kg) per day and will be stored onsite in a lined impoundment. Conditions for the issuance of the license are given. (DLC)

37007 (SAND—78-0108) **Microstructural interactions of geologic media with waste radionuclides.** Hinkebein, T.E.; Hlava, P.F. (Sandia Labs., Albuquerque, N.Mex. (USA)). Mar 1978. Contract EY-76-C-4-0789. 25p. Dep. NTIS, PC A02/MF A01.

A preliminary investigation of the microstructure of four geologic media was taken to examine the interaction of Cs, Sr, Gd and U with those media. Since K/sub D/ measurements often vary by more than an order of magnitude on rocks of the same strata separated by several feet, it was probable that minor rock components play an important role in radionuclide sorption. A qualitative analysis of the rock surfaces after equilibration with solutions of Cs^{+}, Sr^{++}, Gd^{+++} and UO_2^{++} revealed that clay minerals are responsible for all important sorption that takes place on the rocks studied (Magenta dolomite, Bell Canyon silt stone, Eleana shale and clay bearing halite). Thus it is concluded that a relatively small portion of these rocks is actively responsible for sorption characteristics. Gd was bound on all samples, probably as Fe bearing chlorites. Cs was strongly held on the Eleana shale, probably by an illite. Although uranium was associated with an unidentified clay in the halite sample, uranium sorption probably occurred as UO_2CO_3, which would not significantly retard uranium movement at trace concentrations. Similarly Sr was retained only as $SrSO_4$ on Magenta and this mechanism is not significant at trace levels. These analyses were performed by correlating electron microprobe elemental distribution photomicrographs with x-ray analyses of the four rocks.

37008 **Evaluation of the consequences of LWR spent fuel and plutonium shipping package loss at sea.** Heaberlin, S.W.; Baker, D.A.; Beyer, C.E.; Mandel, S.; Peterson, P.L. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). pp 315-322 of Transport packaging for radioactive materials. Vienna; IAEA (1976).

From Symposium on the design, construction and testing of packaging for the safe transport of radioactive materials; Vienna, Austria (23 Aug 1976).

See CONF-760813—.

In ocean shipment of radioactive materials it is conceivable that accidents could occur which would result in loss of the materials into the sea. The effects of two postulated loss situations for typical shipping packages for LWR spent fuel or plutonium dioxide are analysed. These concern loss to the sea of an undamaged package and that of a fire-damaged package. The shipping package for LWR spent fuel is assumed to be a large 100-t mechanically cooled cask. The plutonium dioxide package is a 57-litre specification 6M container with a standard 2R inner containment vessel. In each loss situation the effects are dependent on the ocean depth where the loss occurs. Two ocean locations are considered, the continental shelf (200-m depth) and the deep ocean. The total population dose to man via the marine food chain is calculated. The annual dose to man is determined as a function of the amount released and the productivity of the ocean at the location of the release. Productivity is defined as amount of seafood taken per unit volume sea.

37009 **Environmental surveys of two deepsea radioactive waste disposal sites using submersibles.** Dyer, R.S. (Environmental Protection Agency, Washington, D.C. (USA). Office of Radiation Programs). pp 317-336 of Management of radioactive wastes from the nuclear fuel cycle. Vol. 2. Vienna; IAEA (1976).

From IAEA symposium on the management of radioactive waste; Vienna, Austria (22 Mar 1976).

See CONF-760310—; STI/PUB—433(Vol.2).

This paper discusses the use of the manned submersible ALVIN and the unmanned submersible CURV III to survey disused U.S. radioactive waste dumpsites at depths of 2800m in the Atlantic ocean and 900 and 1700m in the Pacific Ocean. Data are presented showing the presence of plutonium contamination in sediments collected within a cluster of both intact and breached packages at the 900m dumpsite area in the Pacific. The level of sup(239,240)Pu contamination in surface sediments is shown to be from 2 to 25 times higher than the maximum expected concentration that could have resulted from weapons testing fallout. Data are also presented cofirming the presence of ^{137}Cs contamination in the 2800m Atlantic dumpsite with concentrations ranging from 3 to 70 times higher than the maximum expected fallout concentration. Packaging records, photographs of the coring operations, and information written on the waste packages themselves establish a direct relationship between the radioactive waste packages and the contamination in the adjacent sediments. Mechanisms of vertical redistribution of caesium and plutonium are discussed. Bioturbation is suggested as the most probable factor in the redistribution of plutonium in the 900 and 1700m Pacific-Farallons subsites, while leaching from packages and periodic burial of the leached wastes by lateral sediment transport may account for the deep vertical distribution of ^{137}Cs in sediments at the 2800m Atlantic site. The potential significance of this radionuclide contamination of the dumpsites is discussed in terms of the evidence for possible physical transport of the radioactive material and the presence of edible marine species.

37010 **Radionuclide dynamics and health implications for the New York Nuclear Service Center's radioactive waste burial site.** Matuszek, J.M. (New York State Dept. of Health, Albany (USA)); Strnisa, F.V. (Division of Industrial Sciences and Technologies, New York State Department of Commerce, Albany, USA); Baxter, C.F. (New York State Energy Research and Development Authority, USA). pp 359-371 of Management of radioactive wastes from tye nuclear fuel cycle. Vol. 2. Vienna; IAEA (1976).

A commercial radioactive waste burial site has operated since 1963 at the Western New York Nuclear Service Center. Solid low-level radioactive wastes are buried in trenches excavated from a very fine-grained heterogeneous mixture of silt and clay (silty till) and are then covered with the excavated material. Despite many operational precautions, water levels in three burial trenches rose to within a few centimeters of the covering material by late 1973. Tritium concentrations measured in void-space water from vertical cores appeared to peak in the cover material 1.5 to 2m below the ground surface. Concentrations of ^{90}Sr and ^{137}Cs in the silty till were greatest near the surface of the cover material. Concentrations of HTO and ^{90}Sr, measured in a series of slant-hole core samples collected until the trench was intercepted, showed tritium migration to have progressed less than 0.3m, while ^{90}Sr migration appeared to be somewhat less. The preliminary data suggest that: (a) radionuclide migration from the burial trenches into the undisturbed silty till is slight; (b) radioactivity in the surface soil is not necessarily caused by migration of trench water; (c) groundwater movement is not massive; (d) rainwater infiltration, with settlement and compaction of buried wastes, is the most likely cause of rising trench water levels; and (e) surface contamination may occur from spills during burial operations, from trench digging, and from deposition of stack effluents from a nearby nuclear fuel reprocessing plant. By January 1975 the steadily rising water levels in three trenches were approximately 1m above the undisturbed soil from which the trenches were excavated, resulting in increased radioactivity levels in local streams draining the site. To lower the trench water levels to below that of the undisturbed soil, water was removed from the trenches, treated to reduce activity levels, and released to local streams.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 36985, 37811, 38209, 38237

37011 (KFK—2435, pp 147-151) **Investigation of the long-term radiological environmental impact caused by an accumulation of nuclear facilities.** Bayer, A.; Beier, B.G.; Kalckbrenner, R.; Schueckler, M. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik). Apr 1977. (In German).

In Second semiannual report 1976.

The program for the calculation of the radiological impact on the population via the various exposure pathways has been finished. Results have been obtained by making use of this program for the Upper-Rhine-Region. By inserting some preparatory work for the German risk study a delay in the documentation occurred. The documentation will be issued during the first half of 1977. In a further study the build-up of heavy isotopes in the cores of different reactor types were investigated and the resulting throughputs in a reprocessing plant have been derived. Using attainable decontamination factors, the resulting release rate can be estimated.

37012 (NUREG/CR—0005) **Critique of the solid angle method.** Oden, D.R.; Lewallen, M.A.; Thompson, J.K.; Trapp, T.J. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Sep 1977. Contract EY-76-C-06-1830. 60p. Dep. NTIS, PC A04/MF A01.

Results of a study to investigate the margin of safety associated with the application of the solid angle neutron interaction method to evaluate the criticality safety of arrays of fissile units are presented. The study was primarily concerned with the application of the method to low enriched (< or = to 5 wt % ^{235}U) uranium systems, since LWR fuel fabrication is a major area of application of the method today. However, some work on fully enriched U and Pu systems was included. Several combinations of allowed conditions, which although predicted to yield a safe array by the solid angle method, actually yielded a critical array when calculated by the KENO-IV code with Hansen-Roach cross sections. It was not possible to demonstrate the validity of the solid angle method for the general case. The problem areas identified did suggest some possible additional criteria or limitations which might be applied to render the method valid for a given area of application. One possible approach would be to limit the application to water reflected arrays of well moderated units with < or = to wt % ^{235}U and unit k/sub eff/s based on optimum moderation within the units. Whether or not a given set of these criteria or limitations is complete for a specific application remains to be tested. Based on limited results it is recommended that caution be exercised in the use of the solid angle

method in areas where it has not been shown to be valid by comparison to more sophisticated array evaluation techniques.

REGULATIONS

37013 **U.S. non-proliferation policies.** Chayes, A. pp 73-80 of Uranium supply and demand. London; Mining Journal Books (1977).
From 2. symposium on uranium supply and demand; London, UK (22 Jun 1977).
See CONF-7706120—.
Reasons are advanced for the proposal to slow down the programmes on reprocessing and on breeder reactors, in order to reduce the quantity of plutonium being made available at the present time.

ACCOUNTABILITY AND SAFEGUARDS

REFER ALSO TO CITATION(S) 37523, 37524, 38708

37014 (COO—4571-1) **Nonproliferation alternative systems study. Progress report, September 1, 1977—January 1, 1978.** Benedict, M.; Miller, M. (Massachusetts Inst. of Tech., Cambridge (USA). Energy Lab.). Feb 1978. Contract EN-77-S-02-4571. 48p. (MIT-EL—78-001). Dep. NTIS, PC A03/MF A01.
The following issues are addressed: problems in "post-attribute" development of a methodology for assessing the proliferation resistance of nuclear power systems; the inherent proliferation resistance of the front end of the denatured thorium cycle; and irradiation of fresh LMFBR fuel as a means of increasing the proliferation resistance of this cycle. The calculation presented here assumes pre-irradiation to 1% of maximum burnup (100,000 MWD/MT or 1000 MWD/MT). (LK)

37015 (COO—4571-2) **Workshop on institutional aspects of proliferation resistance. Summary report, December 19, 1977.** Dalzell, M.; Miller, M. (Massachusetts Inst. of Tech., Cambridge (USA). Energy Lab.). Feb 1978. Contract EN-77-S-02-4571. 29p. (MIT-EL—78-002). Dep. NTIS, PC A03/MF A01.
A one-day workshop was held to improve understanding of the overall structure of the proliferation problem and the role institutional/political arrangements can play in support of technological measures to prevent proliferation. (LK)

37016 (HEDL-TME—77-29) **Rod scanner assay of FFTF fuel.** Goris, P. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Jan 1978. Contract EY-76-C-14-2170. 29p. Dep. NTIS, PC A03/MF A01.
Rod scanner results for over 40,000 FFTF Cores 1 and 2 fuel pins are summarized. An improved rod scanner calibration technique for FFTF Cores 3 and 4 fuel pins is described. Data are compared with chemical assay measurements. 5 fig., 5 tables.

37017 (UCID—17525-77-2) **Safeguards material control at licensed processing facilities. Quarterly report, April—June 1977.** Hollstien, R.B.; Maimoni, A.; Spogen, L.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1977. Contract W-7405-ENG-48. 28p. Dep. NTIS, PC A03/MF A01.
This is the third quarterly report of progress at LLL on assessment methodologies and tools to assist the NRC in the development and enforcement of performance based regulations pertaining to special nuclear material safeguards at licensed facilities. The first quarterly report presented an overview of LLL's approach as of February, 1977. The second quarterly report describes the design of a hypothetical material control system referred to as the "test bed design" which is being used at LLL in the development of techniques for the assessment of material control system effectiveness. This report describes one of these techniques, a specialized computer simulation program for determination of material control system responses to particular adversary action sequences that constitute a material diversion attempt. The report contains an overview description of the Material Control System Simulator (MCSS) program and its role in the LLL assessment procedure. The complete MCSS User's Manual is available in the LLL report UCID 17727. This and the previous quarterly are detailed topical reports and do not present progress made in other areas of this program. Future quarterly reports will resume broad coverage of all aspects of LLL's assistance to the NRC on Safeguards Material Control at Licensed Processing Facilities.

37018 **Nuclear fuel microsphere gamma analyzer.** Valentine, K.H.; Long, E.L. Jr.; Willey, M.G. (to Energy Research and Development Administration). US Patent 4,021,669. 3 May 1977. Filed date 15 Mar 1976. 4p.
PAT-APPL-666,534.
A gamma analyzer system is provided for the analysis of nuclear fuel microspheres and other radioactive particles. The system consists of an analysis turntable with means for loading, in sequence, a plurality of stations within the turntable; a gamma ray detector for determining the spectrum of a sample in one section; means for analyzing the spectrum; and a receiver turntable to collect the analyzed material in stations according to the spectrum analysis. Accordingly, particles may be sorted according to their quality; e.g., fuel particles with fractured coatings may be separated from those that are not fractured, or according to other properties. 4 claims, 3 figures.

37019 **Canadian safeguards policies.** Haynal, G. pp 81-86 of Uranium supply and demand. London; Mining Journal Books (1977).
From 2. symposium on uranium supply and demand; London, UK (22 Jun 1977).
See CONF-7706120—.
Canadian safeguards policy is described: Canadian nuclear materials and facilities may be used only for peaceful (non-explosive) purposes; inter-governmental guarantees are required from importing countries to ensure this. In future new supply commitments will only be concluded with non-weapon states that have ratified the non-proliferation treaty or to states that have through some other means accepted an equally binding commitment for non-proliferation and internationally applied full scope safeguards.

FUSION FUELS

FABRICATION AND TESTING

REFER ALSO TO CITATION(S) 38690

PROPERTIES

37020 (UCRL—52391) **Quadrupole mass-filter sensitivities of H_2, HD, D_2, and T_2, and the kinetics of β-particle induced exchange between H_2, D_2, and T_2 at 25.4°C.** Pyper, J.W.; Kelly, E.M.; Magistad, J.G.; Tsugawa, R.T.; Roberts, P.E.; Souers, P.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 11 Jan 1978. Contract W-7405-ENG-48. 34p. Dep. NTIS, PC A03/MF A01.
We have constructed a quadrupole-mass filter system to measure the equilibrium constants and rates of reaction of the β-particle-induced exchanges between H_2, D_2, and T_2 at cryogenic temperatures. Even with careful calibration experiments at 25.4°C, we could not completely remove the mass discrimination inherent in our method. We estimate the accuracy of our mixture analyses to be +-2.2% in the D_2-DT-T_2 system, and +-9% in the H_2-HT-T_2 system. Preliminary kinetic experiments showed that the time to reach equilibrium in the exchange $H_2 + T_2 = 2HT$ is 7 to 14 h. The equivalent time interval in the exchange $D_2 + T_2 = 2DT$ is 3 to 7 h. This measured isotope effect of two can be used to predict the rates of the DT exchange from the HT rates in the literature.

ISOTOPE AND RADIATION SOURCE TECHNOLOGY

37021 (ORNL/TM—6241) **Stable isotope customer list and summary of shipments, FY 1977.** Davis, W.C. (Oak Ridge National Lab., Tenn. (USA)). Apr 1978. Contract W-7405-ENG-26. 39p. Dep. NTIS, PC A03/MF A01.
Portions of document are illegible.
The compilation of stable isotope customers and shipments is divided into four parts. There are alphabetical lists of domestic and foreign customers, alphabetical list of isotopes with cross-references to customers, alphabetical list of states and customers with cross-reference to customers, and tabulation of shipments, quantities, and dollars. (JSR)

PHYSICAL ISOTOPE SEPARATION

REFER ALSO TO CITATION(S) 37785, 37841

37022 **Isotope separation by magnetic fields.** Dawson, J.M. (to TRW Inc.). US Patent 4,081,677. 28 Mar 1978. Filed date 17 Feb 1976. 20p.
One of the isotopes of an element having several isotopes can be separated from the others in a dense, neutral plasma. Thus initially a neutral plasma is prepared including the element in question. This

may consist of positive ions and negative electrons or alternatively of positive and negative ions, or else of a mixture of positive ions, negative ions and electrons. The plasma may then be injected into a magnetic field or may be generated in the field where more energy is imparted to a selected isotope than to the others. Finally, the isotopes are separated from each other on the basis of their differential energies. For example, the selected isotope may be given more energy than the others by stimulating it within the plasma at its resonant frequency which may be close to the cyclotron frequency, either by an electric field or by a magnetic field. In order to excite the other isotope, a different resonant frequency is required which depends on the plasma density, the relative concentration of electrons if the plasma contains electrons, the strength of the magnetic field, the ratio of charge to mass of the isotope, and possibly on the physical parameters of the plasma apparatus itself, such as the ratio of the length of the plasma column to its radius. The more energetic isotope may be separated by energy dependent chemical reactions, it may be collected by a positively biased probe or else the isotopes may be separated from each other by magnetic fields or in various other ways.

RADIATION SOURCES

DESIGN AND FABRICATION

REFER ALSO TO CITATION(S) 37625

OTHER INDUSTRIAL USES

37023 (SAND—78-0647C) **Beneficial uses of nuclear fission wastes.** Sivinski, H.D. (Sandia Labs., Albuquerque, N.Mex. (USA); Sandia Labs., Livermore, Calif. (USA)). 31 Mar 1978. Contract EY-76-C-04-0789. 9p. Dep. NTIS, PC A03/MF A01.

Sandia is investigating the use of ^{137}Cs from radioactive waste to reduce the pathogen levels of municipal sewage sludges so that they can be used in agriculture, either as fertilizer or as feed supplement. The Sandia Irradiator for Dried Sewage Solids (SIDSS) is a pilot plant for treating 16 tons per day to a dose of 500 krad, using 1 MCi of ^{137}Cs. A larger (25 ton/day) demonstration plant is also planned. A cost/benefit study of this application was made. Use of ^{99}Tc for marine bifouling and corrosion inhibition is also being investigated. (DLC)

ISOTOPIC POWER SUPPLIES

DESIGN AND FABRICATION

37024 (LA—7256-PR) **General-Purpose Heat Source Project, Space Nuclear Safety Program, and Radioisotopic Terrestrial Safety Program. Progress report, March 1978.** Baker, R.D. (comp.). (Los Alamos Scientific Lab., N.Mex. (USA)). Apr 1978. Contract W-7405-ENG-36. 31p. Dep. NTIS, PC A03/MF A01.

The formal monthly report covers the studies related to the use of $^{238}PuO_2$ in radioisotopic power systems carried out for the Advanced Systems and Materials Production Division by the Los Alamos Scientific Laboratory. The three programs involved are: (1) general-purpose heat source development; space nuclear safety; and radioisotopic terrestrial safety. Most of the studies discussed here are of a continuing nature. Results and conclusions described may change as the work continues. Published reference to the results cited in this report should not be made without the explicit permission of the person in charge of the work.

HYDROGEN

37025 **Potential structural material problems in a hydrogen energy system.** Gray, H.R. (NASA Lewis Research Center, Cleveland); Nelson, H.G.; Johnson, R.E.; McPherson, W.B.; Howard, F.S.; Swisher, J.H. *Int. J. Hydrogen Energy;* **3**: No. 1, 105-118(1978).

Potential structural material problems that may be encountered in the three components of a hydrogen energy system--production, transmission/storage, and utilization--have been identified. Hydrogen embrittlement, corrosion, oxidation, and erosion may occur during the production of hydrogen. Hydrogen embrittlement is of major concern during both transmission and utilization of hydrogen. Specific materials research and development programs necessary to support a hydrogen energy system are described. An awareness of probable shortages of strategic materials has been maintained in these suggested programs.

PRODUCTION

37026 **Hydrogen purification by selective adsorption.** Sircar, S.; Zondlo, J.W. (to Air Products and Chemicals, Inc.). US Patent 4,077,779. 7 Mar 1978. Filed date 15 Oct 1976. 16p.

Hydrogen-containing gas mixtures are subjected to selective adsorption in a pressure swing cyclic system to remove carbon dioxide and/or hydrocarbon gases, obtaining high recovery of hydrogen at high purity. The system can also be employed for separation of methane from admixture with CO_2.

37027 **Magma: a potential source of fuels.** Northrup, C.J.M. Jr.; Gerlach, T.M.; Modreski, P.J.; Galt, J.K. (Sandia Labs., Albuquerque, NM). *Int. J. Hydrogen Energy;* **3**: No. 1, 1-10(1978).

Recent calculations and measurements indicate that basaltic magma is a new, extensive source for fuels (hydrogen, carbon monoxide, and methane). The fuel production processes have been found to occur in nature as well as the laboratory and as a result, our work indicates that current concepts of geothermal energy can be broadened beyond producing only steam and heat. When magma is considered as a geothermal resource, its use for the direct production of fuels should be included. It is possible to generate several mole percent hydrogen when water-rich fluid is equilibrated with the ferrous and ferric iron in magma. This paper describes the basis of the fuel production processes, the fuel yields for injected water and water plus natural organic matter (biomass), and the increased geothermal resources that would be made available by these processes.

37028 **Process and apparatus for the production of hydrogen and carbon dioxide.** Ranke, G. (to Linde AG). US Patent 4,050,909. 27 Sep 1977. Priority date 30 Oct 1975, German, Federal Republic of (F.R. Germany). 10p.

For the separation of substantially pure carbon dioxide and a gas enriched in hydrogen, said gases being especially suitable for the production of urea via an intermediate ammonia synthetic and reaction with CO_4 a system is provided of (a) scrubbing a raw gas consisting essentially of carbon dioxide, hydrogen and hydrogen sulfide in a first scrubbing stage with a first fraction of partially loaded physical scrubbing agent, e.g., methanol, to obtain a partially scrubbed raw gas depleted in H_2S and a more loaded scrubbing agent; (b) scrubbing said partially scrubbed raw gas in a second stage with physical scrubbing agent to obtain a further scrubbed raw gas enriched in hydrogen and said partially loaded physical scrubbing agent; (c) subjecting said more loaded scrubbing agent to at least one (preferably two) pressure reducing stages to obtain a gaseous phase therefrom; (d) subjecting a second fraction of said partially loaded scrubbing agent to at least one pressure-reducing stage to obtain reduced pressure liquid phase substantially free of hydrogen sulfide; and (e) scrubbing said gaseous phase of step (c) with at least a fraction of liquid phase of step (d) to obtain a scrubbed substantially pure carbon dioxide and hydrogen sulfide.

ELECTROLYSIS

REFER ALSO TO CITATION(S) 37039, 37079, 37108, 37353

37029 **High efficiency water electrolysis in alkaline solution.** Appleby, A.J.; Crepy, G.; Jacquelin, J. (Centre de Recherches de la C.G.E., Marcoussis, France). *Int. J. Hydrogen Energy;* **3**: No. 1, 21-37(1978).

Methods of increasing the efficiency and lowering the capital cost of state-of-the art pressure-type electrolyzers are briefly reviewed. A doubling of current density, accompanied by a halving of the internal resistance, and improved electrode activity are required. The latter may be obtained by catalysis and increases in effective surface and temperaturee. An increase in the temperature to 120—130°C appears feasible without giving rise to materials problems provided asbestos separators are not used. All of the above are examined in detail, and it is shown that advanced electrodes with non-precious catalysts will be capable of operating at 1.55 (I.R. included) at 0.4 A/cm², 120°C and 30 to 40 atm., which corresponds to isothermal operation.

37030 **Hydrogen by electrolysis to supplement pipeline gas supplies: technical and economic aspects.** Guerra, C.R.; Ku, W.S. (Public Service Electric and Gas Co., Newark, NJ). pp 133-139 of New options in energy technology. New York; American Institute of Aeronautics and Astronautics, Inc. (1977).

From Conference on new options in energy technology; San Francisco, CA, USA (2 Aug 1977).

See CONF-770824—.

The use of hydrogen as an energy carrier to transfer low-cost off-peak energy from base-load electric-generating units to peaking units, or to a companion gas utility system, has the potential of improving system-utilization efficiency and augmenting pipeline gas supplies. This paper summarizes PSE and G experience in the following areas of hydrogen technology: (1) operation of a test

facility to produce and store hydrogen for electricity production at peak demand times, (2) distribution and utilization of hydrogen containing refinery gas, (3) studies of blends of hydrogen with natural gas and (4) system evaluation of natural gas supplementation with electrolytic hydrogen.

STEAM REFORMER PROCESSES

REFER ALSO TO CITATION(S) 37569

BIOSYNTHESIS AND PHOTOCHEMICAL PROCESSES

37031 Gas chromatographic determination of dissolved hydrogen and oxygen in photolysis of water. Valenty, S.J. (General Electric Corporate Research and Development, Schenectady, NY). *Anal. Chem.;* **50**: No. 4, 669-670(Apr 1978).

In an attempt to observe trace quantities of H_2 and O_2 which might be evolved during the photolysis of glass supported monolayer assemblies of surfactant derivatives of tris(2,2'-bipyridine) ruthenium(II), a simple chromatographic method has been used and is described. In this method, the aqueous solution is injected directly onto a chromatographic column filled with molecular sieves and the eluting H_2 and O_2 monitored by a standard thermal conductivity detector. (LK)

STORAGE

CHEMISORPTION

REFER ALSO TO CITATION(S) 37030, 37036

37032 Determination of the hydrogen sorption characteristics of metallic materials by thermogravimetric methods. Lutz, H.M.; De Pous, O. pp 8p, Paper 1F5 of Hydrogen in metals. Volume 7. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P7.

A high temperature and pressure microbalance is described for the investigation of metal-hydrogen systems. The instrument performance was demonstrated by measurements on the $Mg_2Ni—H_2$ system.

37033 Nuclear magnetic resonance studies of diffusion in FeTiH/sub x/. Bowman, R.C. Jr.; Attalla, A.; Carter, G.C.; Chabre, Y. (Mound Lab., Miamisburg, OH). pp 8p, Paper 1F12 of Hydrogen in metals. Volume 7. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P7.

Proton NMR of FeTiH/sub x/ has been studied for x values in the β and γ hydride phases. Knight shifts, linewidths, spin-lattice relaxation times, and spin-spin relaxation times have been measured and a temperature of sudden hydrogen loss has been observed. Activation energies have been deduced from these measurements.

37034 Hydrogen in La—Ni compounds: localization and diffusion. Busch, G. (Laboratorium fuer Festkoerperphysik ETH, Zurich); Schlapbach, L.; Thoeni, W.; v. Waldkirch, T.; Fischer, P.; Furrer, A.; Haelg, W. pp 8p, Paper 1D7 of Hydrogen in metals. Volume 7. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P7.

We have determined the symmetry of the hydrogen sublattice and the occupancies of the hydrogen sites in La—Ni hydrides by neutron diffraction. The neutron inelastic scattering technique has been used to study the dynamics of the hydrogen atoms.

37035 Hydrogen sorption properties of AB_2 laves phase pseudobinary compounds. Jacob, I.; Shaltiel, D.; Davidov, D. (Hebrew Univ. of Jerusalem). pp 6p, Paper 1D12 of Hydrogen in metals. Volume 7. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P7.

The hydrogen absorption capacity, N/sub H/, and the plateau equilibrium pressure, P/sub eq/, in the hydrogen dissociation isotherms of the hydrides of the pseudobinary compounds Zr(A/sub x/B/sub 1-x/$_2$ (A = V, Cr Mn; B = Fe, Co; $0 < x < 1$) have been studied. We found N/sub H/ and P/sub eq/ to vary significantly with the composition, x.

TRANSPORT

REFER ALSO TO CITATION(S) 37108

INDUSTRIAL AND COMMERCIAL USE

REFER ALSO TO CITATION(S) 37619

37036 Hydrogen-powered mass transit system. Billings, R.E. (Billings Energy Corp., Provo, UT). *Int. J. Hydrogen Energy;* **3**: No. 1, 49-59(1978).

Hydrogen's application to mass transit systems is considered. A 21-passenger bus is converted to hydrogen using a Dodge engine which has been modified for high compression operation. Backfiring and nitric oxide pollution formation are controlled by a water injection technique. Hydrogen fuel storage for the experimental prototype is accomplished by two metal hydride containers using an iron—titanium alloy. Data are presented regarding equipment conversion and design, energy resource utilization, economics, and safety.

37037 Development of a liquid hydrogen car. Furuhama, S.; Hiruma, M.; Enomoto, Y. (Musashi Inst. of Tech., Tokyo). *Int. J. Hydrogen Energy;* **3**: No. 1, 61-81(1978).

Due to stricter emission control standards and the higher cost of fossil fuels, hydrogen is considered to be of great promise as a future automotive fuel. However, the problem of on-board storage has yet to be solved. At present, storage of the hydrogen as a liquid is the only method in practice. In order to participate in the SEED Rally held in the U.S.A. in 1975, a Datsun B-210 passenger car with a 1.4 liter engine was converted to a hydrogen fueled car using the liquid storage method. This was accomplished within the short space of 4 months. Since the car had to travel at least 650 km (400 miles) between fuelings, it was equipped with a tank which could contain 2301 (61 gal) of liquid hydrogen at 5 atm. gage (70 psig). Because cooler hydrogen gas induces better engine performance, the fuel line from the rear tank to the front engine was a vacuum insulated pipe. Fuel was injected intermittently into the intake port by a mechanical valve. This car successfully completed the Rally, 2800 km (1730 miles), and proved that the liquid hydrogen car has a bright future with regard to energy economy, performance, emissions, and safety.

37038 Hydrogen: primary or supplementary fuel for automotive engines. Finegold, J.G. (California Inst. of Tech., Pasadena). *Int. J. Hydrogen Energy;* **3**: No. 1, 83-104(1978).

Hydrogen, gasoline, and mixtures thereof were compared as fuels for lean-burn engines. Hydrogen for the mixed fuels tests was generated by partial oxidation of gasoline. Hydrogen combustion yielded the highest thermal efficiency at any NO/sub x/ level. Gasoline yielded the second highest thermal efficiency for NO/sub x/ levels greater than or approximately equal to 2 g/mile. For lower NO levels and high vehicle inertia weights, progressively more hydrogen supplementation was the second most efficient system. For vehicle inertia weights below 5000 lbm (2300 kg), the statutory NO standard (0.4 g/mile) could be let with one lbm/h (0.13 g/s) hydrogen supplementation.

37039 Hydrogen-via-electricity: a candidate transitional transportation energy system concept. Ecklund, E.E.; Escher, W.J.D. (Energy Research and Development Administration, Washington, DC). pp 140-149 of New options in energy technology. New York; American Institute of Aeronautics and Astronautics, Inc. (1977).

From Conference on new options in energy technology; San Francisco, CA, USA (2 Aug 1977).

See CONF-770824—.

There is an implacable need to move transportation off of oil. However, the strategic alternatives for creating a non-petroleum energy base for transportation, as in the case of all other sectors, are all long-term, costly systems, each having technical and socio-economic limitations and constraints which will govern their eventual constributions. The eventual non-petroleum transportation energy base cannot be specified today. To "preserve all options," yet take positive steps to obviate serious transportation-energy shortfalls, transitional steps must be implemented beginning in the relatively near-term. The hydrogen-via-electricity (HVE) concept has been proposed as one candidate transitional system. This system utilizes the in-place electrical utility energy delivery systems to produce hydrogen energy via water electrolysis at selected vehicular fueling points. Vehicles, converted to operate on hydrogen, could then be operated indirectly on coal and nuclear energy primarily, thereby moving off oil. The HVE concept has relatively near-term potential for supporting a certain fraction of such critical tranportation modes as the railroads, intercity trucking, buses and fleet vehicles of various kinds. Environmental benefits will also accrue.

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PROPERTIES

37040 Errors associated with the stirred reactor for the determination of rate constants of the H_2--O_2 reactions. Rashidi, M. (Arya Mehr Univ. of Tech., Tehran); Karim, G.A. *Int. J. Hydrogen Energy;* **3**: No. 1, 39-47(1978).

The paper describes an investigation into the uncertainty in the deduced rate constants of H_2—O_2 reactions resulting from measurement and interpretation errors associated with the stirred reactor apparatus. It is suggested that the interpretation and measurement of reactor temperature and heat transfer contributed to the highest uncertainty in the deduced rate constants, while the measurement of equivalence ratio, loading and inlet gas temperature was comparatively less important. By considering uncertainties in the measurements for two reactor operating conditions, it was shown that the rate constants for three elementary reactions can be adjusted successfully.

37041 Test procedures of hydrogen induced cracking of steel for natural gas transportation. Blanchard, F.; Sourdillon, D. (Centre d'Etudes Vallourec, Aulnoye-Aymeries, France). pp 8p, Paper 4A8 of Hydrogen in metals. Volume 6. Elmsford, NY; Pergamon Press Inc. (1977). (In French)

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P6.

The test procedures and special ultrasonic control to evaluate the hydrogen-induced cracking sensitivity of pipeline steels are described. Application to the study of the effects of metallurgical factors and comparison with other methods are given.

OTHER SYNTHETIC AND NATURAL FUELS

HYDROCARBON FUELS

REFER ALSO TO CITATION(S) 37108

PROPERTIES

REFER ALSO TO CITATION(S) 37786, 37814

PREPARATION

REFER ALSO TO CITATION(S) 37026

CHEMICAL SYNTHESIS

37042 (FE—2467-5) **Transition metal-graphite catalysts for production of light hydrocarbons from synthesis gas. Quarterly report, August 1, 1977—October 31, 1977.** Rosynek, M.P. (Texas A and M Univ., College Station (USA). Dept. of Chemistry). Nov 1977. Contract EX-76-C-01-2467. 29p. Dep. NTIS, PC A03/MF A01.

Commercial kieselguhr-supported cobalt (containing 39 wt% Co) is an effective catalyst, at 200 to 300°C, for the Fischer-Tropsch hydrogenation of carbon monoxide. For reaction in a batch system at a total initial pressure of 1 atm and an initial H_2/CO reactant ratio of 2/1, methane is the major carbon-containing product observed in all cases, with selectivities ranging from approximately 55% at 200°C to approximately 90% at 300°C. The increase in selectivity to methane with increasing reaction temperature occurs primarily at the expense of the C_4^+ hydrocarbon fraction which decreases from approximately 30 mole% of the carbon-containing product at 200°C to virtually zero at 300°C. Production of C_2-C_3 hydrocarbons, on the other hand, is affected much less by variations in reaction temperature, remaining relatively constant at 5 to 10% of the total product over the temperature range studied. The total initial rate of carbon monoxide conversion at 250°C is approximately 1.2 moles of CO/mole of Co/hr, with a temperature coefficient of 23.8 kcal/mole. The reaction rate decreases with increasing "time-on-stream" and stabilizes at only approximately 5% of its initial value after 15 to 20 total hrs of use at 250°C and 1 atm. A doubly-promoted catalyst, containing Co : ThO_2 : MgO = 31.4 : 1.9 : 3.8 wt% on kieselguhr, exhibited a much higher activity, per cobalt atom, and generated substantially less methane and more C_4^+ hydrocarbons at 200 to 225°C than did the unpromoted cobalt catalyst. However, its use resulted in considerably higher levels of coke deposition and consequent loss of carbon from the gas phase.

37043 Partial oxidation process. Slater, W.L. (to Texaco Inc.). US Patent 4,074,981. 21 Feb 1978. Filed date 10 Dec 1976. 12p.

A continuous process is described for producing simultaneously a stream of cooled clean synthesis gas, reducing gas, or fuel gas and a separate stream of superheated steam. In the subject process a hydrocarbonaceous fuel is reacted with a free-oxygen containing gas by partial oxidation in the reaction zone of a free-flow noncatalytic gas generator. The effluent gas stream from the reaction zone is quenched in water in a quench zone and further cooled by being passed serially through first and second heat exchange zones to produce a product gas stream of cooled clean synthesis gas, fuel, or reducing gas. Simultaneously, a stream of boiler feed water is converted into superheated steam by stepwise sequential indirect heat exchange with the following sources of heat: first with a stream of carbon-quench water dispersion from the quench zone, second with the effluent gas stream in the second heat exchange zone, and third with the effluent gas stream in the first heat exchange zone. Optionally, the process gas stream may be cooled further, scrubbed with water, passed through a separating zone to remove entrained water, and expanded in a gas turbine for the production of mechanical or electrical energy.

PREPARATION FROM WASTES OR BIOMASS

REFER ALSO TO CITATION(S) 37027, 37076, 38188

37044 Kinetic and surface study of the thermal decomposition of cellulose powder in inert and oxidizing atmospheres. Fairbridge, C.; Ross, R.A.; Sood, S.P. (Lakehead Univ., Thunder Bay, Ont.). *J. Appl. Polym. Sci.;* **22**: No. 2, 497-510(Feb 1978).

The thermal decomposition of fibrous cellulose powder from 275° to 340°C has been studied by thermogravimetry, scanning electron microscopy, krypton adsorption, and gas-chromatographic analysis of the gaseous products arising from pyrolysis in various oxidizing and inert atmospheres. The reaction kinetics fit a phase boundary model where the rate is controlled by the movement of an interface through a cylindrical particle and the principal kinetic parameters fit a compensation curve described previously for the decomposition of wood products. An explanation of the physical mechanism of pyrolysis is proposed which is consistent with the observed rate data and the structural changes observed by scanning electron microscopy. 2 tables, 10 figures, 24 references.

ALCOHOL FUELS

REFER ALSO TO CITATION(S) 37108

PREPARATION

PREPARATION FROM WASTES OR BIOMASS

REFER ALSO TO CITATION(S) 38188

37045 Microcalorimetric study of yeast growth, utilization of different carbohydrates. Schaarschmidt, B.; Lamprecht, I. (Freie Univ., Berlin). *Thermochim. Acta;* **22**: No. 2, 333-338(Feb 1978).

The anaerobic growth of the yeast Saccharomyces cerevisiae on six different mono- and disaccharides was investigated calorimetrically. From the thermograms the kinetic data for the sugar uptake were determined. This method holds for biphasic growth (diauxy) on mixed sugars too.

INORGANIC HYDROGEN COMPOUND FUELS

REFER ALSO TO CITATION(S) 37108

PREPARATION

REFER ALSO TO CITATION(S) 37028

HYDRO ENERGY

RESOURCES AND AVAILABILITY

37046 Water power in Finland. Part I. Korpela, K. (Univ. of Turku, Finland). *Int. Water Power Dam Constr.;* **30**: No. 3, 38-40(Mar 1978).

The earliest documented use of water power in Finland was in the year 1352, for a water mill. Until the turn of the last century this form of energy was extensively exploited for flour mills and industry, and only then did its potential for electrical energy begin to be developed. A discussion is given on exploiting the hydro resources, electricity consumption, hydroelectric resources, and regulation of water courses in Finland.

37047 Hydroelectric resources of Columbia. Oramas, G. (Univ. of Valle, Cali, Columbia). *Int. Water Power Dam Constr.;* **30**: No. 3, 41-45(Mar 1978).

At present only about 7 to 8% of Colombia's technically feasible hydro potential has been exploited. Studies undertaken over the past four years which have resulted in the identification of 400 potential sites for reservoirs, and plans for multipurpose developments are described. The country aims to increase its installed capacity to 700 MW by 1984.

PLANT DESIGN AND OPERATION

REFER ALSO TO CITATION(S) 37056, 37488, 37489, 37560

37048 Calculating load rejection surges. Ramsahoye, S.I. (Shawinigan Engineering Co. Ltd., Montreal). *Int. Water Power Dam Constr.;* **30**: No. 3, 28-33(Mar 1978).

A simple method for determining surge water levels following load rejection in a hydro station is proposed which gives results very close to those obtained by more time-consuming techniques. The primary surge is determined in a stepwise fashion by pocket calculator, and the secondary surge in one step only. The proposed method for solving load rejection surges in a power canal is based on storage in the channel and on a conceptual model of the behavior of the secondary surge. The method allows the solution of the primary surge in two steps, or more if required, and the solution of the secondary surge in one step only. The method is quick and simple compared with the classical solution by the "Johnson method". In the particular example illustrated the results are within 2% of the "Johnson method". The method can also be applied to a partial rejection of the load.

37049 Intakes and penstocks at Reza Shah Kabir. Eberhardt, A. (Harza Engineering Co., Chicago). *Int. Water Power Dam Constr.;* **30**: No. 3, 34-36(Mar 1978).

At the Reza Shah Kabir dam in Iran, several unusual features were incorporated in the design of the intakes and penstocks which simplified construction, and resulted in financial economies. A discussion is given of gate and hoists, structural and hydraulic design, and performance.

37050 Srinagarind multipurpose scheme in Thailand. Kanchanaphol, L. (Electricity Generating Authority of Thailand, Nonthaburi). *Int. Water Power Dam Constr.;* **30**: No. 3, 46-47(Mar 1978).

With a potential of 720 MW, the Srinagarind project, under construction on the Quae Yai river in Thailand, is one of the largest multipurpose schemes in South East Asia. A general description is given of the rockfill dam and related structures, and also details of current progress at the site.

37051 Closed system, standpipe operated hydroelectric power plant. Pelin, C. US Patent 4,075,838. 28 Feb 1978. Filed date 22 Jul 1977. 8p.

A power plant of the type disclosed in U.S. Patent No. 3,991,563 is housed in a pressure chamber filled with a body of water having a standpipe relatively upstanding thereabove to pressure the water.

37052 Dimensioning of pump-turbines. Kaufmann, J.P. (Vevey Engineering Works, Switzerland). *Int. Water Power Dam Constr.;* **29**: No. 8, 34-37(Aug 1977).

A set of guidelines are presented to aid the design engineer in choosing pump-turbine specifications for a particular application. A dimensional characteristic figures used include: speed (rotation); peripheral speed coefficient; pressure; discharge coefficient; torque coefficient; power; thrust coefficient; and cavitation coefficient. Rough graphs are given of pump-turbine characteristics in the pumping and turbining modes. (PMA)

37053 Construction and operation of the Jerdap-Iron Gates hydro scheme. Stchegolev, G.S.; Basaric, R.; Galperin, M.I. (Leningrad Metal Works). *Int. Water Power Dam Constr.;* **29**: No. 8, 48-51(Aug 1977).

Features of the 2050 MW Jerdap-Iron Gates hydro plant, located on the Danube at the border of Yugoslavia and Romania, are described. Factors such as the pre-assembly and testing of some of the hydraulic components before installation, were of particular value in ensuring that all the units and associated equipment were commissioned on time. Six years of operating experience are also described.

37054 Laos hydro scheme survives political storm. Pluess, A.E. (Motor-Columbus Consulting Engineers Inc., Switzerland). *Energy Int.;* **14**: No. 8, 18-19(Aug 1977).

Hydraulically generated electrical energy is the most important export product and source of foreign exchange in Laos, likely to become more predominant in the future. The second phase of the Nam Ngum development in Laos is intended to earn foreign exchange by exporting some of its output to neighboring Thailand. When the Indochina war came to an end and new political alignments formed in the area, construction was hampered by closure of the frontier. Since then, work has resumed, but with a greater participation of Laotian labor than hitherto and the project is well on the way to completion.

37055 Hydroelectric plant capability curves. Alley, W.T. (Army Corps of Engineers, Atlanta). *IEEE Trans. Power Appar. Syst.;* **PAS-96**: No. 3, 999-1003(1977).

From IEEE PES summer meeting; Portland, OR, USA (18 Jul 1976).

The preparation and use of plant capability curves for conventional hydroelectric projects are discussed. The curves relate the turbine performance curves to actual field conditions so that one can tell at a glance the capability and the corresponding discharge of the plant.

ENVIRONMENTAL ASPECTS

LAND USE AND AESTHETICS

37056 Potential for new hydropower development by the Corps of Engineers. Graves, E. (Army Corps of Engineers, Washington, DC). *IEEE Trans. Power Appar. Syst.;* **PAS-96**: No. 3, 1039-1041(1977).

From IEEE PES summer meeting; Portland, OR, USA (18 Jul 1976).

A discussion is given of the U.S. Army Corps of Engineers' efforts to identify potential sites at which additional or new hydroelectric generating capacity could be developed. It also traces past development of hydroelectric generation by the Corps up to present day installations of turbines and generators using slant-axis technology at specific Corps projects.

POWER CONVERSION SYSTEMS

37057 Selecting hydraulic reaction turbines. Washington, DC; Government Printing Office (1976). 55p. .

This engineering monograph includes information on the development, working requirements, design, operation, capacity and performance of hydraulic reaction turbines used for the incidental generation of power at irrigation dams operated by the Bureau of Reclamation. The data presented enables the design engineer to select the paper turbine unit, to estimate its dimensions, and to predict its performance. (LCL)

SOLAR ENERGY

RESOURCES AND AVAILABILITY

REFER ALSO TO CITATION(S) 37085, 37087

37058 Flat plate collectors and solar water heating. London; International Solar Energy Society (1977). 27p.

The possibilities for solar energy in the United Kingdom are explored. The following subjects are covered: flat plate collectors, solar heating systems, solar energy availability, estimating the benefits of solar water heaters, the use of flat plate collectors for space heating, building regulations and planning controls, and economic considerations. Included in appendices are: flat plate collector thermal performance characteristics, and selective surfaces performance and methods of preparation. (MHR)

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ECONOMICS

REFER ALSO TO CITATION(S) 37069, 37080, 37092, 37093, 37097, 37122

ENVIRONMENTAL, LEGAL, AND INSTITUTIONAL ASPECTS

REFER ALSO TO CITATION(S) 37081

37059 (DOE/EDP—0001) **Environmental Development Plan (EDP): solar heating and cooling of buildings, 1977.** (Department of Energy, Washington, D.C. (USA)). Mar 1978. 54p. Dep. NTIS, PC A04/MF A01.

This Environmental Development Plan (EDP) for the ERDA Solar Heating and Cooling Program briefly describes the present status and goals of the program, and identifies potential environmental, health, safety, and socioeconomic impacts of solar heating and cooling technology development and deployment. These impacts are screened for "key issues." A management plan then is presented for conducting and coordinating environmental research in concert with technology development to ensure that environmental issues are resolved prior to significant public deployment of the technology.

SOLAR ENERGY CONVERSION

REFER ALSO TO CITATION(S) 37543, 37564

PHOTOVOLTAIC CONVERSION

REFER ALSO TO CITATION(S) 37082, 37083

37060 (DOE/JPL/954334—77/4) **Establishment of the feasibility of a process capable of low-cost, high-volume production of silane (Step I) and the pyrolysis of silane to semiconductor-grade silicon (Step II). Low Cost Silicon Solar Array Project, Silicon Materials Task. Quarterly progress report, July—September 1977.** Breneman, W.C.; Farrier, E.G.; Rexer, J. (Union Carbide Corp., Sistersville, W.Va. (USA)). Jan 1978. Contract NAS-7-100-954334. 36p. Dep. NTIS, PC A03/MF A01.

Silane produced via the redistribution of dichlorosilane and purified by distillation followed by adsorption of residual chlorosilane on activated carbon yields 50 ohm-cm silicon on epitaxial deposition. Extended operation of a small process-development unit routinely produced high-quality silane in 97+% yield from dichlorosilane. The production rate was consistent with design loadings for the fractionating column and for the redistribution reactor. Laboratory and process-development reactor systems were built to study the hydrogenation of co-product silicon tetrachloride. An integrated unit for converting hydrogen and silicon to silane is also under construction. A glass fluid-bed reactor was constructed for room-temperature operation. The behavior of a bed of silicon particles was observed as a function of various feedstocks, component configurations, and operating conditions. For operating modes other than spouting, the bed behaved in an erratic and unstable manner. A second reactor with a modified gas-feed system for increased bed stability is being constructed. In some free-space reactor experiments, friable clusters of silicon particles formed on the tip of the gas injector and on the reactor wall. The temperature at the growth sites was the major parameter controlling the extent of these formations. It was also shown that within limits, the particle size of the reactor product can be modified by controlling the temperatures of the reactor and of the injected silane. A method was developed for casting molten silicon powder into crack-free solid pellets for process evaluation. The silicon powder was melted and cast into thin-walled quartz tubes that sacrificially broke on cooling. The samples are intended for resistance and spark-source mass spectroscopic analysis.

37061 (DOE/JPL/954343—77/4) **Process feasibility study in support of silicon material, Task I. Quarterly technical progress report (IX).** Fang, C.S.; Hansen, K.C.; Miller, J.W. Jr.; Yaws, C.L. (Lamar Univ., Beaumont, Tex. (USA). Dept. of Chemical Engineering). Dec 1977. Contract NAS-7-100-954343. 27p. Dep. NTIS, PC A03/MF A01.

Major activities were devoted to process system properties, chemical engineering and economic analyses. Analyses of process system properties were continued for silicon source materials under consideration for solar cell grade silicon production. Major activities focused on properties of silicon tetrachloride which is the source material for several alternate processes. Status and progress are reported for vapor pressure, heat of vaporization, heat capacity, density, surface tension, viscosity, thermal conductivity, heat of formation and Gibb's free energy of formation. Experimental thermal conductivity values for hydrogen, determined for instrument accuracy evaluation, were in very good agreement with recommended values from the literature. The deviations were only +-2% up to 300°C. Preliminary results for gas phase thermal conductivity are reported for silane (SiH_4) and dichlorosilane (SiH_2Cl_2) in the respective temperature ranges, 25 to 300°C and 25 to 400°C. There have been no previously reported experimental data in the literature for these silicon source materials. Major efforts were continued on the preliminary process design of the silane process. Progress and status are reported for key items. The process flow diagram, material balance and energy balance are 100% complete for the revised flowsheet. Major process equipment design is 85% complete. Estimate of production labor requirements is 75% complete.

37062 (DOE/JPL/954374—4) **Slicing of silicon into sheet material. Silicon sheet growth development for the large area silicon sheet task of the Low Cost Silicon Solar Array Project. Seventh quarterly report, September 19, 1977—December 17, 1977.** Holden, S.C.; Fleming, J.R. (Varian Associates, Lexington, Mass. (USA). Lexington Vacuum Div.). 12 Jan 1978. Contract NAS-7-100-954374. 118p. Dep. NTIS, PC A06/MF A01.

Fabrication was begun on a prototype large capacity multiple blade slurry saw. Final concept and design is nearly complete on the bladehead which will tension up to 1000 blades, and cut a 45 cm long silicon ingot as large as 12 cm in diameter. The large blade tensioning force of 270,000 kg (600,000 lbg) will be applied through two bolts acting on a pair of scissor toggles, significantly reducing operator set-up time. Poor wafering yields have caused concern in recent tests with MS slicing. The cause for poor yield, namely perimeter fracture of slices, also impacts the solar cell production yield of 10 cm diameter thin (250—350μ) silicon slices. Recent tests with an "upside-down" cutting technique has resulted in 100% wafering yields and the highest wafer accuracy yet experienced with MS slicing. Variations in oil and abrasive have resulted only in degraded slicing results. A technique of continuous abrasive slurry separation to remove silicon debris is described.

37063 (DOE/JPL/954521—77/3) **Integral glass encapsulation for solar arrays. Interim report No. 1, May 1976—July 1977.** Younger, P.R.; Kreisman, W.S.; Kirkpatrick, A.R. (Spire Corp., Bedford, Mass. (USA)). Nov 1977. Contract NAS-7-100-954521. 91p. Dep. NTIS, PC A05/MF A01.

A fourteen month effort to develop integral glass encapsulation for solar cell arrays is described. Electrostatic bonding (ESB) has been used to join silicon solar cells to borosilicate glass without the aid of any organic binders or adhesives. The results of this investigation have been to demonstrate the feasibility of this process as an encapsulation technique. The potential of ESB for terrestrial solar arrays was shown. The process is fast, reproducible, and produces a permanent bond between glass and silicon that is stronger than the silicon itself. This makes moisture tight sealing of solar cells possible.

37064 (DOE/JPL/954830—12) **Assessment of present state-of-the-art sawing technology of large diameter ingots for solar sheet material. First quarterly report, September 1—November 30, 1977.** Yoo, H.I. (Optical Coating Lab., Inc., City of Industry, Calif. (USA). Photoelectronics Div.). 1977. Contract NAS-7-100-954830. 55p. Dep. NTIS, PC A04/MF A01.

The objective is to assess the present state-of-the-art sawing technology of large diameter silicon ingots (3" and 4" diameter) for solar sheet materials. Work has progressed in three areas: (1) Slicing of the ingots with the multiblade slurry saw and the internal diameter (I.D.) saw, (2) Characterization of the sliced wafers, and (3) Analysis of direct labor, expendable material costs, and wafer productivity. This analysis for both sawing methods showed that the I.D. saw slicing technique is more favorable than multiblade slurry slicing techniques at present.

37065 (DOE/JPL/954887—1) **Continuous Czochralski process development. LSSA large area silicon sheet task. Quarterly report No 1, October—December 1977. Texas Instruments report No. 03-77-55.** Rea, S.N. (Texas Instruments, Inc., Dallas (USA)). Jan 1978. Contract NAS-7-100-954887. 14p. Dep. NTIS, PC A02/MF A01.

A continuous Czochralski silicon furnace employing liquid silicon melt replenishment is being developed. Designs of the various furnace components are in process. Experiments exploring several auxiliary crucible designs to supply the liquid silicon feed were conducted. Results indicate that a graphite RH element containing a cylindrical quartz crucible can melt the required silicon flow rate. However, achieving liquid silicon flow into the primary crucible presents a sizeable technical obstacle requiring considerable experimental work to effect a workable design. Initial economic modeling of a 100 kg continuous furnace run indicates an add-on crystal cost around $1.96/cm length at 100% crystal yield. With a sawing yield

of 20 slices/cm the add-on silicon sheet cost is $12.50/m^2 exclusive of slicing costs.

37066 (DOE/JPL/954888—1) **Continuous Czochralski growth. Silicon sheet growth development of the large area silicon sheet task of the Low Cost Silicon Solar Array Project. First quarterly progress report, October—December 1977.** (Kayex Corp., Rochester, N.Y. (USA)). 31 Dec 1977. Contract NAS-7-100-954888. 16p. Dep. NTIS, PC A02/MF A01.

The development of equipment and processes to produce single crystal solar silicon by a continuous Czochralski method was studied. "Continuous" is defined as the ability to produce 100 kilograms of crystal from only one melt container. The equipment to be used is a Hamco CG2000 Production Crystal Grower. Certain modifications will be made to the grower to enable periodic replenishment of silicon into the crucible and removal of grown crystals. The crystal grower was constructed and installed in a separate room designated and prepared for the project. It was adapted with a modified throat, a vacuum-tight isolation valve, an enlarged pull chamber to hold a supply of poly material, and a modified automatic diameter control (ADC) optical system. It was fully tested and made ready for trial runs. Designs are under way for other modifications to the equipment, including a recharge system, a polysilicon attachment device, and a modified bead-chain pull mechanism capable of pulling and simultaneously weighing a 30 to 40 Kg growing crystal. An economic model was developed for batch CZ as a base-line reference, and for two methods of continuous CZ. Preliminary analysis indicates a cost (value added by crystal growth) of approximately $13 to $17 per kilogram of usable crystal for continuous CZ versus $33.00 for state of art methods. This model will be updated as additional data, process parameters and equipment requirements are obtained.

37067 (DOE/JPL/954901—1) **Development and evaluation of die materials for use in the growth of silicon ribbons by the inverted ribbon growth process: Task II. LSSA Project. Quarterly report No. 1.** Duffy, M.T.; Berkman, S.; Cullen, G.W.; Moss, H.I. (RCA Labs., Princeton, N.J. (USA)). Dec 1977. Contract NAS-7-100-954901. 30p. (PRRL—77-CR-53). Dep. NTIS, PC A03/MF A01.

Silicon sessile drop experiments were performed on a variety of commercially available refractory carbides, nitrides, oxides, and borides to examine the potential of these materials for applications involving either direct contact with molten silicon or as substrates for CVD coatings in the fabrication of dies and crucibles for containing molten silicon. Simultaneous experiments were also conducted with CVD layers of SiC, Si_3N_4, and SiO/sub x/N/sub y/. The latter two materials proved superior for purposes of contact with the silicon melt in relation to chemical reactivity and reduced impurity content. Silicon nitride layers, deposited with NH_3 : SiH_4 ratios ranging from 100 : 1 down to 5 : 1, were examined in sessile drop experiments to determine if the layers are degraded as a result of using lower reagent ratios. The cost of ammonia (5 nines purity) at the higher ratios represents the major cost in the production of these layers, and a reduction in the above ratio could result in a substantial reduction in cost. Preliminary experiments were undertaken on the stability of CVD Si_3N_4 near the melting point of silicon. From our initial experiments it appears that the rate of decomposition is less than 100 A/h just below the melting point of silicon. Silicon ribbon segments were grown from vitreous carbon dies which had been coated with CVD Si_3N_4. Depending upon the purity of the die materials, ribbon resistivity values up to 40 Ω-cm were obtained.

37068 (DOE/JPL/954914—1) **High velocity continuous-flow reactor for the production of solar grade silicon. First quarterly report.** Woerner, L. (Schumacher (J.C.) Co., Oceanside, Calif. (USA)). Dec 1977. Contract NAS-7-1-100-954914. 40p. Dep. NTIS, PC A03/MF A01.

This program is designed to test the feasibility of a high volume, high velocity continuous reduction reactor as an economical means of producing solar grade silicon. Bromosilanes and hydrogen are used as the feedstocks for the reactor along with preheated silicon particles which function both as nucleation and deposition sites. Efforts have been devoted to the investigation of system design and system materials of construction. A complete reactor system has been designed and fabricated. Initial preheating studies have shown the stability of tetrabromosilane to being heated as well as the ability to preheat hydrogen to the desired temperature range. Several test runs have been made and some silicon was obtained from runs carried out at temperatures in excess of 1180°K.

37069 (DOE/NASA/1022—77/24) **Photovoltaic remote instrument applications: assessment of the near-term market.** Rosenblum, L.; Scudder, L.R.; Poley, W.A.; Bifano, W.J. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). Dec 1977. Contract EY-76-C-05-1022. 18p. (NASA-TM—73881). Dep. NTIS, PC A02/MF A01.

A preliminary assessment of the near-term market for photovoltaic remote instrument applications is presented. Among the potential users, two market sectors are considered: government and private. However, the majority of the remote systems studied are operated by or for the federal, state, or local governments. Two types of remote instrument systems, environmental monitoring and surveillance, are discussed. Based on information obtained in this preliminary market survey, a domestic, civilian market of at least 1.3 MW/sub pk/ (cumulative through 1985) is forecast for remote instrument systems. This estimate is exclusive of several potentialy large-scale markets for remote instruments which are identified but for which no hard data is available.

37070 (DOE/NASA/1022—78/27) **Results of module electrical measurement of the DOE 46-kilowatt procurement.** Curtis, H.B. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). Feb 1978. Contract EX-76-A-29-1022. 21p. (NASA-TM—78829). Dep. NTIS, PC A02/MF A01.

I-V measurements have been made on 661 of the Block I terrestrial solar cell modules of the DOE/JPL Low Cost Silicon Solar Array procurement. Data on I/sub sc/, V/sub oc/, and P/sub max/ for the four types of modules are presented in normalized form, showing distribution of the measured values. Standard deviations from the mean values are also given. Tests of the statistical significance of the data are discussed.

37071 (ERDA/JPL/954376—77/4) **Laser-zone growth in a Ribbon-to-Ribbon (RTR) process, silicon sheet growth development for the large area silicon sheet task of the Low Cost Silicon Solar Array Project. Annual report.** Gurtler, R.W.; Baghdadi, A.; Ellis, R.J.; Legge, R.; Sopori, B. (Motorola, Inc., Phoenix, Ariz. (USA). Semiconductor Group). Sep 1977. Contract NAS-7-100-954376. 121p. Dep. NTIS, PC A06/MF A01.

The Ribbon-to-Ribbon (RTR) approach to silicon ribbon growth is investigated. An existing RTR apparatus is to be upgraded to its full capabilities and operated routinely to investigate and optimize the effects of various growth parameters on growth results. A new RTR apparatus is to be constructed to incorporate increased capabilities and improvements over the first apparatus and to be capable of continuous growth. Material analyses and solar cell fabrication process optimization are to be performed with a goal of 12% cell efficiency. Major progress towards completion of the new laser lab has been made with full operation expected in October. RTR No. 1 has been used for routine growth of samples for analysis and fabrication into solar cells. One lot of solar cells has been completely evaluated: ribbon solar cell efficiencies averaged 9.23% with a highest efficiency of 11.7%. Spherical reflectors have demonstrated significant improvements in laser-silicon coupling efficiencies. Numerous material analyses have been performed including SPV and OCPV diffusion length measurements, crystal morphology studies, modulus-of-rupture measurements, and annealing/gettering studies. An initial economic analysis has been performed indicating that RTR add-on costs of $.10/watt might be expected in the early 1980's. Engineering drawings of the improved transport stage and of the components for the RTR apparatus are included in one of the appendices.

37072 (ERDA/JPL/954458—77/7) **Interim report on accelerated/abbreviated test methods, Study 4, Task 3 (encapsulation) of the Low-Cost Silicon Solar Array Project, April 1, 1976—October 24, 1977.** Kolyer, J.M.; Mann, N.R. (Autonetics, Anaheim, Calif. (USA)). 24 Oct 1977. Contract NAS-7-100-954458. 130p. Dep. NTIS, PC A07/MF A01.

Methods of accelerated and abbreviated testing were developed and applied to solar cell encapsulants. These encapsulants must provide protection for as long as 20 years outdoors at different locations within the U.S. Consequently, encapsulants were exposed for increasing periods of time to the inherent climatic variables of temperature, humidity, and solar flux. Property changes in the encapsulants were observed. The goal was to predict long-term behavior of encapsulants based upon experimental data obtained over relatively short test periods. To simplify the experimental design, weather conditions throughout the U.S. were categorized into arbitrary "environmental cells." Each cell covered a distinct interval of temperature, humidity, and solar intensity. In accelerated exposure, the values for constants in a generalized rate equation were obtained for encapsulant degradation in each cell. Then it should be an easy matter to sum the extents of degradation as the weather passes from cell to cell and so arrive at a prediction for cumulative degradation. Comparison of such predictions with actual values obtained under outdoor exposure in a specific locale should verify the mathematical model and prediction methodology. The first attempts to accelerate degradation under fixed conditions in the laboratory have been made. Changes in encapsulant properties were observed and correlated with these artificial conditions. Increase in chromophore concentration in the encapsulant (yellowing) was found to be directly proportional to the cumulative ultraviolet radiation both outdoors and in accelerated exposure. Another inno-

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vation was to expose encapsulants "in situ," i.e., applied directly onto miniature solar cell arrays.

37073 (IS—4350) **Preparation of thin film solar cells under very low pressure conditions. Final report, October 1, 1976—September 30, 1977.** Schmidt, F.A.; Shanks, H.R.; Bevolo, A.J.; Campisi, G.J. (Ames Lab., Iowa (USA)). 1977. Contract W-7405-ENG-82. 79p. Dep. NTIS, PC A05/MF A01.

In this study the feasibility of fabricating backwall Schottky barrier polycrystalline solar cells under ultra-high vacuum conditions of 1 x 10^{-10} torr (N_2) was investigated. Thin films of electron beam vaporized silicon were deposited on cleaned metal substrates of tungsten, tantalum and hafnium. Mass spectra from the quadrapole residual gas analyzer were used to determine the partial pressure of peak heights of 13 residual gases during each processing step. During separate silicon depositions, the substrate temperature was varied between 400 and 750°C and deposition rates between 20 and 750 A/min were used. Surface contamination and metal diffusion were monitored by in situ Auger electron spectrometry before and after cleaning, deposition and annealing. Auger depth profiling, x-ray analysis, and SEM in the topographic and channeling modes, were utilized to characterize the samples with respect to silicon-metal boundary layer, interdiffusion, silicide formation and grain size of silicon. The clean metal surface was found to enhance thin film silicide growth. Fine grain silicon films were obtained for all samples that were not completely converted to a metallic silicide. Tungsten, tantalum and hafnium were found to form silicides at temperatures as low as 600°C.

37074 (SAN—1285-3) **Thin films of silicon on low-cost substrates. Quarterly project report No. 3, March 1, 1977—May 31, 1977.** Chu, T.L. (Southern Methodist Univ., Dallas, Tex. (USA)). Jun 1977. Contract EY-76-C-03-1285. 32p. Dep. NTIS, PC A03/MF A01.

Efforts were directed to the preparation and characterization of silicon films, p—n junctions, and solar cells on purified metallurgical silicon substrates. A final group of passivated epitaxial silicon mesa diodes on metallurgical silicon substrates was prepared, and their dark forward characteristics were measured and analyzed. The results have confirmed the earlier conclusion that carrier recombinations at grain boundaries can be combined with those in the space region in the two-exponential model. A high resolution apparatus for the measurement of potential barriers at grain boundaries in epitaxial silicon films on metallurgical silicon substrates was assembled. Initial measurements indicated a measurable voltage drop at all grain boundaries. Large area (30 cm^2) solar cells prepared by successively depositing p- and n^+-silicon films on purified p^+-metallurgical silicon substrates have AM1 efficiencies of about 7.5%. The spectral response of polycrystalline silicon solar cells was measured under light bias. Preliminary work on the measurement of dopant profile in polycrystalline silicon solar cells by a combination of grooving and spreading resistance techniques was carried out.

37075 **Photocells with intermediate radiation conversion and enhanced concentration of solar radiation (K=2500).** Alferov, Z.I.; Andreev, V.M.; Garbuzov, D.Z.; Larionov, V.R.; Rumyantsev, V.D. (A. F. Ioffe Physicotechnical Institute, Academy of Sciences of the USSR, Leningrad). *Sov. Tech. Phys. Lett. (Engl. Transl.);* **3**: No. 10, 449-450(Oct 1977).

The current-voltage characteristics of Zn-AlAs heterojunction photocells are discussed.

BIOMASS PRODUCTION AND CONVERSION

37076 (COO—2900-12) **Fast production of methane by anaerobic digestion. Progress report, December 7, 1977—January 6, 1978.** Finney, C.D.; Evans, R.S. II; Finney, K.A. (Natural Dynamics, Des Moines, Iowa (USA)). Jan 1978. Contract EY-76-C-02-2900. 76p. Dep. NTIS, PC A05/MF A01.

Detailed pressure data were taken for three anaerobic digesters operating at: (1) 50 rpm pulsed to 350 rpm for 15 seconds every five minutes; (2) 50 rpm pulsed to 350 rpm for 45 seconds every five minutes; and (3) 50 rpm pulsed to 350 rpm for 135 seconds every five minutes. Some background considerations on the design, conduct, and outcomes of biokinetic experiments in stirred, continuous culture systems are presented.

37077 (COO—4076-3) **Algal concentration by ultrafiltration. Monthly report, February 1—28, 1977 and quarterly report, December 1, 1976—February 28, 1977.** Gregor, H.P.; Cardenas, R. (Columbia Univ., New York (USA)). 10 Mar 1977. Contract EY-76-S-02-4076. 18p. Dep. NTIS, PC A02/MF A01.

A number of algal cultures of the fine, non-settling type were concentrated by non-fouling ultrafiltration membranes to the 1 to 3% concentration level at high fluxes and without evidence of membrane fouling. The algae studied include the following: Anabaena, Chlorella, Chlorococcus, Gleotrichia, Microcystis, Phormidium, and Selenastrum. A culture of Nannochloris grown on a mixture of sea water and secondary effluent was similarly concentrated to the 5% level. None of the several algal species investigated thus far have offered any problems. In view of the high fluxes obtained, the estimated cost for concentration by ultrafiltration has been revised downward to approximately three cents per thousand gallons on a very large scale of use, or even less. Ultrafiltration also shows promise of allowing for the recycling of nutrients, making this no longer a factor in limiting energy production from biomass.

37078 (LBL—7548) **Only source of energy.** Calvin, G.J.; Calvin, M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 22 Mar 1978. Contract W-7405-ENG-48. 15p. Dep. NTIS, PC A02/MF A01.

Various plants that might play a role in the energy mix of the future are discussed and illustrated. Included among them are the Euphorbias and Guayule. (JGB)

PHOTOCHEMICAL AND THERMOCHEMICAL CONVERSION

37079 **Role of energy levels in semiconductor-electrolyte solar cells.** Memming, R. (Philips GmbH Forschungslaboratorum, Hamburg). *J. Electrochem. Soc.;* **125**: No. 1, 117-123(Jan 1978).

The transfer of minority carriers across the semiconductor-electrolyte interface during illumination has been studied. In particular the parameters which determine the competition between pure redox processes and hydrogen evolution at p-type or anodic dissolution at n-type material have been investigated. In the first case the electron transfer between p-type electrodes and the redox system can simply be interpreted on the basis of an energy scheme. In the case of hole transfer from n-type electrodes across the interface the competition of a pure redox process and anodic dissolution is more complex. It is mainly determined by kinetic parameters. The results obtained with CdS and various III-V compounds are discussed in view of application of n- and p-type semiconductors in solar energy conversion systems.

PHOTOVOLTAIC POWER PLANTS

REFER ALSO TO CITATION(S) 37070

37080 (ALO—2744-13(Vol.1)) **Conceptual design and systems analysis of photovoltaic power systems. Final report. Volume I. Executive summary.** Pittman, P.F. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Research and Development Center). Apr 1977. Contract EY-76-C-04-2744. 56p. Dep. NTIS, PC A04/MF A01.

Conceptual designs were made and analyses were performed on three types of solar photovoltaic power systems. Included were Residential (1—10 kW), Intermediate (0.1—10 MW), and central (50—1000 MW) Power Systems to be installed in the 1985 to 2000 time period. In the residence, a total energy system where the waste heat from the array is used to heat the dwelling appears optimum. If a suitable government incentive is forthcoming, Residential Systems begin to become economically viable in selected areas in the 1985 to 1990 period, while Intermediate and Central Power Systems begin to become viable in the 1990 to 2000 period. Here, the entire program is summarized.

37081 (ALO—2744-13(Vol.4)) **Conceptual design and systems analysis of photovoltaic power systems. Final report. Volume 4. Nontechnical issues.** Pittman, P.F. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Research and Development Center). Jul 1977. Contract EY-76-C-04-2744. 102p. Dep. NTIS, PC A06/MF A01.

A large number of nontechnical issues that impact upon solar photovoltaic power systems, is described in detail. The rate of implementation of this technology will be determined by an interaction between government and the private sector. Solar photovoltaic system costs will depend upon production volume which, in the near term, will depend upon government incentive programs. A possible scenario studied calls for an annual solar cell installation rate of 500 MW in 1985 increasing to approximately 10,000 MW by 2000. The utility/residence interface deals with the rate to be charged a residential customer purchasing only a small fraction of his total energy needs from a utility while obtaining the majority of his energy from a solar energy system. The rate charged to such a customer will have a significant effect on the overall economic viability of a residential solar photovoltaic power system. A host of secondary impacts resulting from the use of solar photovoltaic energy systems must be considered. These range from the reduction of air pollution to the possibility of locating residences in remote areas without concern about the need for utility feeder lines nearby. Institutional factors to be considered include land use issues, insurance, banking, taxes, etc. Regulatory considerations include building codes, safety considerations, and zoning. National interest concerns include resources, environment, health, demographics, national security, and

national policy. As a result of the study of nontechnical issues performed, none was found that would constitute an impediment to the widespread use of solar photovoltaic energy.

37082 (ALO—2748-12(Vol.2)) **Photovoltaic systems concept study. Final report.** (Spectrolab, Inc., Sylmar, Calif. (USA)). Apr 1977. Contract EY-76-C-04-2748. 240p. Dep. NTIS, PC A11/MF A01.

Separate abstracts were prepared for the two sections.

37083 (ALO—2748-12(Vol.2), pp 3.1-3.105) **System components.** Apr 1977.

In Photovoltaic systems concept study.

Component design data of a general nature is provided for the residential, shopping center, and central power station applications. Photovoltaic array designs are described including the efficiency, cooling, and optical characteristics. Descriptive material associated with power conditioning equipment, utility interfacing techniques, regulators and the energy storage components is provided.

37084 (ALO—2748-12(Vol.2), pp 4.1-4.128) **Residential on-site application.** Apr 1977.

In Photovoltaic systems concept study.

Residential on-site applications are addressed in this section. Two houses were defined, one for eastern locations and one for western locations. Site locations of Phoenix and Riverside were chosen for the western style house. Cleveland and Washington, D.C. were chosen for the eastern style house. These houses are described and the space-conditioning method defined. Various methods of establishing space conditioning load requirements were devised and evaluated in the effort to determine thermal loads accurately and efficiently. These methods and their results are reviewed. To equate space conditioning loads to electrical power requirements required development of analytical models for the various space conditioning equipment. Also, control sequence and control philosophy and/or criteria had to be established. These models and control criteria are reviewed. The electrical loads computed for the selected systems and locations are presented. The photovoltaic power system is defined including the utility grid interface and power conditioning equipment. Array-storage trade-off studies were conducted to determine the optimum ratio of array to storage as a function of the fraction of electrical energy supplied by the photovoltaic system. The techniques developed for this optimization study along with the results and conclusions are given. A cost-performance trade-off study was performed to optimize the size of inverter to be used for the various applications. This work is documented. The economic performance evaluation of these residential on-site systems is reviewed. General observations along with specific conclusions are summarized.

37085 (ALO—2748-12(Vol.3)) **Photovoltaic systems concept study. Final report.** (Spectrolab, Inc., Sylmar, Calif. (USA)). Apr 1977. Contract EY-76-C-04-2748. 240p. Dep. NTIS, PC A11/MF A01.

The work performed in the conceptual design and systems analysis of three sizes of photovoltaic solar electric power systems is contained in five volumes consisting of nine sections plus appendices. Separate abstracts were prepared for the two sections in this volume. (MHR)

37086 (ALO—2748-12(Vol.3), pp 5.1-5.157) **Commercial on-site system design.** Apr 1977.

In Photovoltaic systems concept study.

For purposes of evaluating on-site photovoltaic power generation, two applications were chosen. One was the new construction of an intermediate sized shopping center of 23,200 square meters (250,000 square feet) floor space, located in the San Fernando Valley, a Los Angeles suburb. The other was a retrofit application applied to a small low-rise office building of 3,000 square meters (32,000 square feet) floor space, located near the Los Angeles International airport. An evaluation of the suitability of various classes of light commercial buildings for incorporation of on-site conversion of solar energy is presented. Hourly and seasonal variations in demand as well as average demand density are considered. The considerations discussed led to selection of a shopping center for the design study and to the choice of a low-rise office building for the retrofit study presented here.

37087 (ALO—2748-12(Vol.3), pp 6.1-6.78) **Simplified design method for on-site applications.** Apr 1977.

In Photovoltaic systems concept study.

Using computer simulations to check the formulas, methods were developed of estimating solar fractions of an on-site load from monthly average insolation data. Methods of estimating insolation are presented for various array types for all parts of the continental United States. Loads are briefly discussed. Solar fraction formulas suitable for hand calculation from available monthly insolation data are given. These formulas lead to design methods for sizing on-site solar power systems with utility backup. Comparisons are presented of solar fractions from computer simulations to those predicted with the formulas. The magnitude of the errors in prediction (average 8 percent, maximum 15 percent) due to the formulas compares quite well to the year-to-year variability in monthly insolation. A summary of the design method and recommendations for sizing on-site systems are given.

37088 (ALO—2748-12(Vol.4)) **Photovoltaic systems concept study. Volume IV. Final report.** (Spectrolab, Inc., Sylmar, Calif. (USA)). Apr 1977. Contract EY-76-C-04-2748. 228p. Dep. NTIS, PC A11/MF A01.

This report has been prepared in nine sections plus appendices, separated into five separate volumes. This volume contains three sections. Separate abstracts were prepared for each section. (MHR)

37089 (ALO—2748-12(Vol.4), pp 7.1-7.79) **Central power station design.** Apr 1977.

In Photovoltaic systems concept study.

The conceptual design for the photovoltaic central station power plant is described. Two design options, onsite storage and no storage, are considered. The criteria used as a basis for the designs are considered. A brief description of the plant is given in order to put ensuing detailed discussions into perspective. The sizing of the plant and its systems is discussed. The plant components are discussed in detail. Plant operation and economics are described.

37090 (ALO—2748-12(Vol.4), pp 8.1-8.33) **Central power station operational and economic analysis.** Apr 1977.

In Photovoltaic systems concept study.

The following topics are covered: operational analysis and plant rating, computer simulation results, and economic analysis. (MHR)

37091 (ALO—2748-12(Vol.4), pp 9.1-9.108) **Institutional factors study results.** Apr 1977.

In Photovoltaic systems concept study.

The methodology used for economic analysis is discussed and the estimated cost of PEPS (photovoltaic electric power systems) is compared to the allowable price of PEPS. Both technical and social factors which will influence the development of PEPS are identified. Research, development, and demonstration goals derived from the technical factors identified are specified. The social benefits of PEPS are examined and the appropriate magnitude of government expenditures on the estimated social benefits are estimated. Potential elements of a commercial subsidy for PEPS are examined. The major and minor conclusions derived from the analyses are enumerated. (MHR)

37092 (COO—4094-5) **Solar energy alternatives for the United States Embassy and for rural development projects within the Republic of Upper Volta.** Kern, E.C. Jr. (Massachusetts Inst. of Tech., Lexington (USA). Lincoln Lab.). 7 Mar 1978. Contract EY-76-C-02-4094. 45p. Dep. NTIS, PC A03/MF A01.

This report is organized in three sections/: solar cooling options for the new Embassy office building, electrification of Fada N' Gourma using solar photovolatic versus conventional energy systems and an overview of the potential for village solar photovoltaic energy utilization in Upper Volta. The analysis indicates that the least-cost alternative for cooling the new offices is to modify existing plans, which call for standard electric room air conditioning units, and to incorporate energy conservation measures in the building construction and operation.

37093 (DOE/NASA/1022—78/25) **Photovoltaic village power application: assessment of the near-term market.** Rosenblum, L.; Bifano, W.J.; Poley, W.A.; Scudder, L.R. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). Jan 1978. Contract EY-76-C-05-1022. 30p. (NASA-TM—73893). Dep. NTIS, PC A03/MF A01.

A preliminary assessment of the near-term market for photovoltaic village power applications is presented. One of the objectives of the Department of Energy's (DOE) National Photovoltaic Program is to stimulate the demand for photovoltaic power systems so that appropriate markets will be developed in the near-term to support the increasing photovoltaic production capacity also being developed by DOE. The village power application represents such a potential market for photovoltaics. The price of energy for photovoltaic systems is compared to that of utility line extensions and diesel generators. The potential "domestic"' demand (including the 50 states of the union plus the areas under legal control of the U.S. government) is defined in both the goverment and commercial sectors. The foreign demand and sources of funding for village power systems in the developing countries are also discussed briefly. It is concluded that a near-term domestic market of at least 12 MW (peak) and a foreign market of about 10 GW (peak) exists and that significant market penetration should be possible beginning in the 1981—82 period.

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37094 (DOE/NASA/1022—78/26) **Photovoltaic power system tests on an 8-kilowatt single-phase line-commutated inverter.** Stover, J.B. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). Feb 1978. Contract EY-76-C-02-1022. 18p. (NASA-TM—78824). Dep. NTIS, PC A02/MF A01.

A commercially available single-phase line-commutated inverter has been tested in a photovoltaic power system. Efficiency and power factor were measured as functions of solar array voltage and current. Also, the effects of input shunt capacitance and series inductance were determined. Tests were conducted from 15 to 75 percent of the 8 kW rated inverter input power. Measured efficiencies ranged from 76 percent (at 160 V and 8.0 A) to 88 percent (at 200 V and 18.7 A) at about 50 percent of rated inverter input power. Power factor ranged from 36 percent (at 160 V and 8.0 A) to 72 percent (at 200 V and 28.6 A).

37095 **Silicon solar photovoltaic power stations.** Chowaniec, C.R. (Westinghouse Electric Corp., East Pittsburgh, PA); Ferber, R.R.; Pittman, P.F.; Marshall, B.W. pp 84-89 of New options in energy technology. New York; American Institute of Aeronautics and Astronautics, Inc. (1977).

From Conference on new options in energy technology; San Francisco, CA, USA (2 Aug 1977).

See CONF-770824—.

A review of conceptual designs developed for a central station photovoltaic power plant and summarizes the results of system analyses conducted for these designs. Cost/performance tradeoff evaluations which were conducted for various subsystem designs are discussed. It is shown that arrays employing concentration and tracking are most cost effective for high-cost ($500/kW) solar cells whereas collector/reflector systems are preferred for less-expensive cells. Parametric curves of system busbar energy cost illustrate the relative importance of major subsystems and the complicated tradeoff which exists between additonal cell cost and high efficiency.

37096 **Transmission of power from space to Earth.** Brown, W.C. (Raytheon Co., Lexington, MA). pp 106-116 of New options in energy technology. New York; American Institute of Aeronautics and Astronautics, Inc. (1977).

From Conference on new options in energy technology; San Francisco, CA, USA (2 Aug 1977).

See CONF-770824—.

The transfer of energy from synchronous orbit to earth is accomplished by means of microwave power transmission. Microwave power transmission is a three-step process consisting of (1) generation of microwave power from DC power, (2) the formation of a highly collimated beam of microwaves for transmitting the power, and (3) the capture and rectification of power at the earth end of the system. The technology fulfills the basic requirements for an efficient, reliable and safe system with power handling capability in the 5—10 gigawatt region. The projected DC to DC system efficiency is 60%. A frequency in the 2—3 gigahertz region permits efficient power transfer through the earth's atmosphere. The devices used for energy conversion are described and their integration into a full scale system is discussed.

37097 **Satellite solar power: will it pay off.** Hazelrigg, G.A. Jr. (ECON, Inc., Princeton, NJ). pp 117-123 of New options in energy technology. New York; American Institute of Aeronautics and Astronautics, Inc. (1977).

From Conference on new options in energy technology; San Francisco, CA, USA (2 Aug 1977).

See CONF-770824—.

Satellite solar power appears to be a technically feasible energy source that is not dependent on hydrocarbon fuels. Furthermore, economic studies indicate that there is a reasonable chance that a satellite solar power system can be built and operated on a cost-competitive basis compared to alternative systems for the 2000 to 2025 time period. But the development of this system will require a large front-end investment with no guarantee of paying off in the end. An economic analysis of the front-end investment is outlined and the impact that the current engineering systems studies have on its economic analysis is shown.

37098 **Satellite power system LEO vs GEO assembly issues.** Mockovciak, J. Jr.; Adornato, R.J. (Grumman Aerospace Corp., Bethpage, NY). pp 124-132 of New options in energy technology. New York; American Institute of Aeronautics and Astronautics, Inc. (1977).

From Conference on new options in energy technology; San Francisco, CA, USA (2 Aug 1977).

See CONF-770824—.

A strawman crystal-silicon 5-GW Satellite Power System (SPS) concept formed the basis of a study of construction concepts for building a complete SPS in low earth orbit (LEO) or geosynchronous orbit (GEO). Construction scenarios were evolved, including factory-in-space concepts and operations. Design implications imposed on the SPS satellite as a consequence of in-orbit assembly operations, and related attitude control requirements during assembly in LEO or GEO environments, were also evaluated. Results are presented indicating that complete assembly of an operational SPS in LEO, followed by transport to GEO, does not appear technically desirable. The best mix, however, of LEO versus GEO construction activity remains to be resolved.

37099 **New options for satellite power systems (SPS).** Hanley, G.M. (Rockwell Space Div., Downey, CA). pp vp of New options in energy technology. New York; American Institute of Aeronautics and Astronautics, Inc. (1977).

From Conference on new options in energy technology; San Francisco, CA, USA (2 Aug 1977).

See CONF-770824—.

The overall concept of the SPS is described, including operations, cargo delivery, and construction. The basic system requirements are defined and the current major areas of uncertainties in requirements are identified. Candidate SPS concepts are discussed, with emphasis on new SPS conceptual options. The advantages and disadvantages of the options are described, and the specific weights of the concepts are compared.

SOLAR THERMAL POWER PLANTS

REFER ALSO TO CITATION(S) 37096, 37099

37100 **Integration of solar generation into electric utility systems.** Ballance, J.W. (Southern California Edison Co., Rosemead); Braun, G.W. pp 76-83 of New options in energy technology. New York; American Institute of Aeronautics and Astronautics, Inc. (1977).

From Conference on new options in energy technology; San Francisco, CA, USA (2 Aug 1977).

See CONF-770824—.

The value of solar thermal power plants to an electric utility system has been determined. The relationship between solar powerplant values and solar thermal-storage levels, mix of other resources, and the level of solar generation in the system are described. The operating characteristics of solar generation are discussed, and strategies for optimizing the value of solar generation are described. Current maximum cost levels (in dollars) for solar generation are presented, and target levels for component costs are discussed.

TOTAL ENERGY AND HYBRID SYSTEMS

37101 (SAND—77-0029) **Proceedings of the solar total energy symposium.** (Sandia Labs., Albuquerque, N.Mex. (USA)). Jan 1977. Contract EY-76-C-04-0789. 125p. (CONF-770153—). Dep. NTIS, PC A06/MF A01.

From 2. symposium on solar total energy; Albuquerque, NM, USA (25 Jan 1977).

Seven papers are included. Separate abstracts were prepared for each paper. (MHR)

37102 (SAND—77-0029, pp 3.3-3.19) **Total energy keynote address: solar total energy symposium.** Kurtz, N.D. Jan 1977.

From 2. symposium on solar total energy; Albuquerque, NM, USA (25 Jan 1977).

In Proceedings of the solar total energy symposium.

The term "Total Energy" implies the on-site generation of electricity with the recapturing of the "waste-heat" to satisfy other thermal needs such as heating, cooling or process requirements. The history, present applications, problems, and potential of the concept are reviewed. (MHR)

37103 (SAND—77-0029, pp 5.4-5.18) **Solar total energy program.** Rannels, J.E. (Energy Research and Development Administration, Washington, DC). Jan 1977.

From 2. symposium on solar total energy; Albuquerque, NM, USA (25 Jan 1977).

In Proceedings of the solar total energy symposium.

The goals and objectives of the Solar Total Energy Program are outlined and a description of the program plan is provided. A description of the past accomplishments, current activities and future initiatives is included. Concept development, definition planning, technological development and commercialization are also described.

37104 (SAND—77-0029, pp 6.3-6.16) **Community systems program of ERDA/conservation.** Roberts, J.J. (Argonne National Lab., IL); Cavros, S.N.; Croke, E.J. Jan 1977.

From 2. symposium on solar total energy; Albuquerque, NM, USA (25 Jan 1977).

In Proceedings of the solar total energy symposium.

The objectives of the Community Systems (C.S.) Program are to conduct the necessary RD and D to fully understand the relation-

ships between urban development to meet human needs and efficient energy use; to evaluate the role in community development for integrated community energy systems; and to fully assess and, as possible, promote energy-efficient community designs. This activity will make a significant contribution to the broad goals of ERDA/ conservation by applying advanced energy technologies (for supply, distribution and end-use) and energy and waste management techniques to communities. It is intended to ensure that these technologies achieve significant penetration of residential, commercial and institutional markets. The program emphasizes the identification, assessment, development, demonstration and deployment of integrated community energy systems and energy subsystems optimized for specific target communities. The preliminary taxonomy of target communities reflects a broad array of community sizes, functions and complexities. On the basis of these and other generic descriptors of community characteristics, the RD and D effort will focus on achieving an innovative synthesis of existing, emerging and future technologies into integrated energy systems and subsystems. These integrated systems will be matched with energy-efficient community structural design concepts.

37105 (SAND—77-0029, pp 8.3-8.14) **On-site energy, solar total energy, and paralleling with the grid.** Mackay, R. Jan 1977.

From 2. symposium on solar total energy; Albuquerque, NM, USA (25 Jan 1977).

In Proceedings of the solar total energy symposium.

On-site energy systems, both fuel fired and solar powered, were analyzed for the possibility of significant energy savings and the potential for expanding the nation's generating capacity. The capital cost and the efficiency of these systems can be dramatically improved if they are permitted to be paralleled with the grid. (MHR)

37106 (SAND—77-0029, pp 10.3-10.24) **Thermal storage program: an overview.** Swet, C.J. (Energy Research and Development Administration, Washington, DC). Jan 1977.

From 2. symposium on solar total energy; Albuquerque, NM, USA (25 Jan 1977).

In Proceedings of the solar total energy symposium.

Expected requirements for high temperature thermal energy storage for solar total energy systems are examined in relation to current and projected technology development programs.

37107 (SAND—77-0029, pp 11.4-11.18) **Solar total energy system using a small central receiver collector.** Strickland, J.H. (Texas Tech. Univ., Lubbock); Hildebrandt, A.F. Jan 1977.

From 2. symposium on solar total energy; Albuquerque, NM, USA (25 Jan 1977).

In Proceedings of the solar total energy symposium.

A solar total energy system utilizing a small central receiver collector is described briefly. In addition, a particular application which is ideally suited to the solar total energy system concept is discussed. This application is a 365 day per year daytime operation with excellent correlation between instantaneous electric and thermal power requirements.

OCEAN THERMAL GRADIENT POWER PLANTS

37108 (CONF-780114—1) **Alternative forms of energy transmission from OTEC plants.** Talib, A.; Konopka, A.; Biederman, N.P.; Blazek, C.; Yudow, B. (Institute of Gas Technology, Chicago, Ill. (USA)). 1978. 13p. of Gas Technology, Chicago, IL.

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

The alternative forms of energy transmission from ocean thermal energy conversion (OTEC) plants are compared. The chemical energy carriers considered are the following: gaseous and liquid hhydrogen, liquid ammonia, methanol, gasoline, and methane. The assessment assumes that each of the above energy carriers were transported by barge and/or pipeline. The delivered costs of energy using the above chemical energy carriers are compared for different offshore distances. When comparing the delivered cost of chemical energy with transmission of electricity by submarine cables, the outputs are converted to a common form. Thus, in addition to presenting the production and transportation costs and overall energy efficiency of the chemical energy carriers, we have provided a discussion of the equipment, capital and operating costs, and efficiencies of converting the delivered hydrogen and ammonia into electricity. A concise technical assessment and economic analysis of components associated with the conversion, storage, transportation, and shore-based receiving facilities for the conversion of OTEC mechanical energy to chemical energy, and in some cases conversion of delivered chemical energy to electricity are presented.

37109 **Perspectives on implementing OTEC power.** Jopling, D.G. (Florida Power and Light Co., Miami). pp 90-96 of New options in energy technology. New York; American Institute of Aeronautics and Astronautics, Inc. (1977).

From Conference on new options in energy technology; San Francisco, CA, USA (2 Aug 1977).

See CONF-770824—.

This paper answers three major questions: (1) is OTEC feasible; (2) what are the major problems; and (3) what do these problems mean for the commercialization of OTEC. The analysis concludes that OTEC is scientically feasible; but, that a number of engineering, economic, and institutional problems indicate that OTEC will be a higher-risk, farther-term alternative than some more promising energy sources. Given the presently projected worldwide shortages of major fuels, it would be politically impossible at this time to abandon research on any alternative energy program that might help the U.S. out of the impending energy crisis. The presentation recommends that the many complex problems with developing OTEC technology be recognized fully. The participation of major architect/engineering firms, power-equipment manufacturers, and large electric utilities should be encouraged as strongly as possible. OTEC research should focus on fundamental problem areas such as biofouling and corrosion, advanced heat exchangers, advanced turbines, bottoming cycles, advanced pumps, new materials, new construction techniques, dynamic systems design analysis, and basis oceanographic knowledge, all of which are on the critical path for OTEC commercialization.

SOLAR RADIATION UTILIZATION

SPACE HEATING AND COOLING

REFER ALSO TO CITATION(S) 37059, 37084, 37092

37110 (CONF-771229—P1) **Solar Heating and Cooling Demonstration Program Contractors' Review.** (Planning Research Corp., McLean, Va. (USA)). 1977. Contract EG-77-C-01-2522. 84p. Dep. NTIS, PC A05/MF A01.

From Solar heating and cooling demonstration program contractors review; New Orleans, LA, USA (5 Dec 1977).

Proceedings of the review consist of two volumes. Volume I contains a technical analysis of the project papers presented at the review, an in-depth evaluation and presentation of workshop summary material resulting from the five workshops conducted at the review, and an analysis of the "Request for Information Survey" conducted at the review. This summary includes both a listing of papers by author(s), and a complete attendees list in appendices A and B respectively.

37111 (COO—2858-6) **Integration of evacuated tubular solar collectors with lithium bromide absorption cooling systems.** Ward, D.S.; Duff, W.S.; Ward, J.C.; Loef, G.O.G. (Colorado State Univ., Fort Collins (USA). Solar Energy Applications Lab.). 1978. Contract EY-76-S-02-2858. 5p. (CONF-780114—5). NTIS, MF A01.

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

Portions of document are illegible.

By surrounding the absorber-heat exchanger component of a solar collector with a glass-enclosed evacuated space and by providing the absorber with a selective surface, solar collectors can operate at efficiencies exceeding 50% under conditions of $\Delta T/H/\text{sub } T/ = 75°C.m^2/Kw$ (ΔT = collector fluid outlet temperature minus ambient temperature, H/sub T/ = incident solar radiation on a tilted surface). The high performance of these evacuated tubular collectors thus provides the required high temperature inputs (70 to 88°C) of lithium bromide absorption cooling units, while maintaining high collector efficiency. The performance and analysis of two types of evacuated tubular solar collectors integrated with the two distinct solar heating and cooling systems installed on CSU Solar Houses I and III are studied.

37112 (COO—2867-2) **Direct contact liquid—liquid heat exchanger for solar heated and cooled buildings: pilot plant results. Annual progress report, February 1, 1976—July 31, 1977.** Ward, J.C.; Loss, W.M.; Loef, G.O.G. (Colorado State Univ., Fort Collins (USA). Solar Energy Applications Lab.). Sep 1977. Contract EY-76-S-02-2867. 119p. Dep. NTIS, PC A06/MF A01.

The pilot plant phase of this project has been successfully completed. Despite the fact that the 3 liquids tested in the pilot plant differed significantly in some of their physical properties, the relationship between the volumetric heat transfer coefficient and superficial velocity was the same for the 3 liquids tested. Furthermore, it was shown that this relationship will hold for the liquids not actually tested in the pilot plant. In addition, the relationship between the Nusselt and Peclet numbers was also the same for the 3 liquids tested, again indicating a similar relationship for those liquids not tested. Work not contemplated in the proposal but accomplished in the course of this project included the determination (as a function

of temperature) of the viscosity, density, thermal conductivity, and specific heat of the 3 liquids tested in the pilot plant. Subsequent events showed that this work was essential even though it represented expense and time not included in the funding for this project. Construction of the full-scale unit (approximately 1,000 gallons water storage) has been completed. This tank and the associated pumps, plumbing, instrumentation, etc., are all in a trailer to permit easy movement of the entire unit.

37113 (COO—2868-3) **Evaluation of a residential solar air heating and nocturnal cooling system.** Karaki, S.; Armstrong, P.R.; Bechtel, T.N. (Colorado State Univ., Fort Collins (USA). Solar Energy Applications Lab.). Dec 1977. Contract EY-76-S-02-2868. 161p. Dep. NTIS, PC A08/MF A01.

A solar house heating system is described using approximately 700 sq. ft. of air-heating collectors, 363 cu ft of pebble-bed storage, ducts of various sizes, a blower with a constant speed motor, and automatic controls to collect, store and deliver solar heat to the building space. The design, operation instrumentation and data sysem, data reduction, system performance, economic analysis, and component performance are discussed. (MHR)

37114 (COO—2939-4) **Solar space heating systems using annual heat storage. Progress report, January 1977—June 30, 1977.** Hooper, F.C.; Attwater, C.R. (Toronto Univ., Ontario (Canada). Dept. of Mechanical Engineering). Aug 1977. Contract EY-76-C-02-2939. 70p. Dep. NTIS, PC A04/MF A01.

The methodology followed in arriving at a systematic approach to the design of annual storage solar space heating systems is described. The refinement and modification of the earlier annual storage solar heating system simulation is discussed. The implementation of the modified program to elucidate the performance and the cost-effectiveness of the system under various conditions is reported and the dynamic interaction among the system components is examined. The initial observed data on the performance of the instrumented annual storage system installed in "Provident House", the reference experimental building, are presented. Plans for the continuation of the work are outlined.

37115 (COO—4142-1) **Performance analysis and optimization of the University of Pennsylvania retrofitted solar heated Philadelphia row home. Progress report, October 15, 1976—August 15, 1977.** Lior, N. (Pennsylvania Univ., Philadelphia (USA)). Aug 1977. Contract EG-77-S-02-4142. 22p. Dep. NTIS, PC A02/MF A01.

The design, specification and purchasing phase of the instrumentation and data acquisition system needed for the performance analysis and optimization of the solar heating system, and for the acquisition of Philadelphia weather and insolation data is complete, and is described briefly. A subroutine for the analysis of the effects of the control logic and limits on the performance of the solar system has been written and implemented into the University of Pennsylvania general program SOLSYS. The installation of the instruments is ongoing

37116 (COO—4351-2) **Phoenix City of Colorado Springs Solar Assisted Heat Pump Project. Technical report, July 1—September 1977.** Jardine, D.M.; Jones, D.W. (Kaman Sciences Corp., Colorado Springs, Colo. (USA)). Oct 1977. Contract EG-77-C-02-4351. 185p. Dep. NTIS, PC A09/MF A01.

The work completed to date in documenting the design of packaged Solar Assisted Optimized Heat Pump (SAOHP) systems as a step towards stimulating the advancement of an industrial, commercial, and professional capability for producing and distributing this type of system is covered. The SAOHP system consists of a collector group, a storage group, and an energy transport group. The design for the collector group with first tier parts and assembly lists are included, along with the energy transport group designs for the smaller capacity units. Rating curves are included for the 30,000 BtuH (2-½ ton) unit. A sample program printout for the performance analysis program is presented. Climatic region definition work is included in complete form. The economic analysis format for making life cycle cost comparisons between various available heating and cooling systems and the SAOHP is included.

37117 (LA—7141-T) **Building environmental systems evaluation for the National Security and Resources Study Center.** Terry, M.T. (Los Alamos Scientific Lab., N.Mex. (USA)). Feb 1978. Contract W-7405-ENG-36. 159p. Dep. NTIS, PC A08/MF A01.

A method is presented for manually calculating the approximate annual energy requirements of the heating, ventilating and air conditioning systems of a 60,000 square foot solar heated and cooled building. In addition to a solar source, several energy conservation schemes including return air cooled luminaires, reduced lighting levels, reduced outside air changes, hot and chilled water storage and heat recovery were incorporated into the building systems design and the impact on energy consumption of several design decisions is investigated.

37118 (SAND—78-0433) **Approach to the validation of computer simulation codes.** Kennish, W.J. (Sandia Labs., Albuquerque, N.Mex. (USA)). Mar 1978. Contract EY-76-C-04-0789. 23p. Dep. NTIS, PC A02/MF A01.

A programmatic appraoch to the validation of solar heating and cooling simulation codes is presented. The three codes which are discussed specifically are TRNSYS, FCHART, and SOLCOST. However, the approach is equally applicable to other simulation codes. The need for validation is discussed, followed by a description of a validation philosophy. The philosophy is built on the central concept of increasing the confidence in the codes rather than a yes or no decision on validity. To support the philosophy, a simple but effective methodology is presented and discussed. There also arises the issue of component testing vs. systems testing; this topic is treated in some detail. The parallel issue of controlled vs uncontrolled testing is discussed with the general conclusion that both are required for a comprehensive testing program.

37119 (SOLAR/1001—77/13) **Solar energy system description document. Moulder Corporation, Site ID 050, HUD Grant H2754.** (International Business Machines Corp., Huntsville, Ala. (USA)). 30 Nov 1977. Contract EG-77-C-01-4049. 16p. Dep. NTIS, PC A02/MF A01.

The Moulder Solar Energy System provides space heating and hot water for a private single family dwelling located in West Greenwood, Indiana. Air is forced through roof mounted collector panels where it is heated and then the air transfers this heat, for storage, to a 855 cubic foot rock bin. Space heating is provided directly from the collector panels or by circulation through the rock storage bin. Additional heating is supplied by an auxiliary electric heater if the collected solar energy is not sufficient to meet the heating load. Hot water is provided by circulating the heated air through an air-to-water heat exchanger which preheats the water prior to entering a conventional electric water heater. Additional heat is supplied within the hot water tank as required to maintain the desired water temperature.

37120 (SOLAR/2007—77/13) **Solar energy system description document. Flamboyant Investments site, Site ID 012, PON 2161.** (International Business Machines Corp., Huntsville, Ala. (USA)). 28 Oct 1977. Contract EG-77-C-01-4049. 15p. Dep. NTIS, PC A02/MF A01.

The solar energy system installation for the Flamboyant Investments site is an addition to an existing air conditioning system at the Frenchman's Reef resort hotel at St. Thomas, VI. No solar energy is employed for space or water heating. Solar energy is expected to provide approximately 54% of the heat required by one of the two 200-ton absorption chillers. No energy storage was provided because the solar energy contribution was sized to be less then the demand of the chiller. Auxiliary heat input will be controlled according to the amount of solar energy available and the chiller load. The Frenchman's Reef is a new 300-room multi-story resort and convention complex at St. Thomas. Air conditioning for the lobby, office, and meeting areas is provided by the solar-augmented system. Guest rooms are conditioned with individual electric vapor-compression units.

37121 **Design of a solar heating and cooling data center.** Deutsch, D. (National Bureau of Standards, Washington, DC). pp 257-262 of Generalized data management systems and scientific information. Paris; OECD Nuclear Energy Agency (1978).

From OECD/NEA working group on nuclear information; Berkeley, CA, USA (5 Oct 1977).

See CONF-771062—.

The National Bureau of Standards designed and operates a Data Center serving the Federal Solar Energy Research, Development and Demonstration Program. The design effort included thorough consideration of the applicability of generalized database management software. The functional requirements for the Data Center and the factors influencing the database decision are described. A modified database approach is presented and reasons for its adoption by the Data Center are discussed.

37122 **Solar heating in North America.** Duffie, J.A.; Beckman, W.A. (University of Wisconsin, Madison, Wisc.). *Mech. Eng.;* **99**: No. 11, 36-45(Nov 1977).

The economic competitiveness of solar space heating is surveyed using calculations of the performance of liquid system solar heating and hot water systems at 82 stations in the United States and five in Canada. At these stations monthly average solar radiation and temperature data was available. At each station thermal performance calculations were made for four different types of collectors. Using collector costs and fuel energy costs, collector areas that maximize annual energy savings were determined. For each location, the break-even fuel costs are shown. General results show that the Rocky Mountains states provide the most favorable climate for the introduction of solar heating.

37123 Large solar heating system for a Saudi campus complex. Glover, F. *Build. Syst. Des.;* 77: No. 5, 28-43(Aug-Sep 1977).

Sverdrup and Parcel were commissioned by the Army Corps of Engineers to design a school for the Saudi Arabian Government. The solar heating potential was found to be very good in Saudi Arabia due to the extremely clear sky. The design heat load was 36,000 gallons per day of domestic hot water and a winter time space heating load of an equivalent amount. Passive designs helped to make the project economically feasible. Energy efficient features were integrated into the architectural design of the building. A collector design with a selective surface and a single cover glass was found through a computer model to be the most cost effective. Detailed descriptions are given of the space heating and hot water systems. Schematic drawings of the different types of systems are included in the article. The cost effectiveness was estimated on a 20-year life cycle cost basis. Seventy per cent of the heating load is supplied by the solar heating system. The 70% breaks down into 100% of the domestic hot water needs and 40% of the space heating. The system is considered usable for a total of 30 to 35 years.

37124 Noti solar greenhouse: performance and analysis. Hoff, E.; Jenkins, D.; Van Duyn, J. Eugene, OR; Univ. of Oregon (1977). 34p.

The actual performance of a passive polar heated greenhouse is examined with respect to the intentions of its designers, its capacity for the raising of plants and vegetables and its viability for application in the Pacific Northwest. Recommendations are made that would improve greenhouse performance without any increase in operating cost. The greenhouse is below ground on the north side and the north slope of the roof has 12" of sod. Recycled and locally available materials are used where possible. (MHR)

37125 New solar heating/cooling system. *Ind. Pet. Monde, Gaz - Chim.;* **44**: No. 471, 12(May 1976).

The solar-MEC, was demonstrated at the Third Energy Technology Conference (Wash., D.C. 1976) by Gas Development Corp., an institute of Gas Technology subsidiary, which has conducted research on the concept since 1966. The fully operating system, housed in a trailer with solar collectors on the roof, heats, cools, and controls humidity without using compressors, special fluids, or condensing coils. The residential-sized unit has 3 tons/hr of cooling capacity and 100,000 Btu/hr of heating capacity. Its ability to use low-grade solar heat for air cooling in summer exceeds that of all other known systems; this provides the maximum savings of conventional gas heat by use of solar augmentation. The solar collectors on the roof heat water, which drives the environmental control unit for both heating and cooling. The environmental control unit was constructed for Gas Development by Air Enterprises, Inc., and the vacuum-jacketed glass-tube solar collectors were manufactured by Owens-Illinois, Inc.

37126 Pumping in the Sun's heat. *Domest. Heat. News;* **15**: No. 4, 12(Apr 1975).

The Battelle Institute's Columbus Labs., in a study for US National Science Foundation are developing a combined heat pump/solar heating system for homes. The concept involves a solar-heated working fluid to drive a low friction heat pump instead of being circulated to radiators for direct heating; the heat pump could provide heating or cooling, if run in reverse.

AGRICULTURAL AND INDUSTRIAL PROCESS HEAT

37127 (ORO—5042-1) **Solar industrial process heat for kiln drying lumber. Final report, Phase I.** Robertson, S.J.; McCormick, P.O. (Lockheed Missiles and Space Co., Inc., Huntsville, Ala. (USA). Research and Engineering Center). 30 Mar 1977. Contract EY-76-C-05-5042. 67p. (LMSC-HREC-TR-D—497234). Dep. NTIS, PC A04/MF A01.

The design phase of the total program is described. The heat load and temperature requirements for the kiln are defined. A preliminary design of the system is made in which major system components are identified. Then, cost and performance optimization analyses are performed to define the optimum system configuration. Finally, an economics analysis is performed for the selected system design.

37128 (SOLAR/2005—77/13) **Solar energy system description document. Iris Images system, Site ID 010, PON 2146.** (International Business Machines Corp., Huntsville, Ala. (USA)). 28 Oct 1977. Contract EG-77-C-01-4049. 19p. Dep. NTIS, PC A02/MF A01.

The Iris Images solar energy installation provides process hot water for a photographic film processing laboratory located in Mill Valley, California. Auxiliary heating is supplied by a 270,000 BTU/Hr gas heater. The system consists of two banks of collectors, constructed on-site, which provide 640 square feet of absorber surface, 360 gallons of solar-heated hot water storage in three 120 gallon tanks, a 100 gallon gas heated auxiliary back-up, a pump and interconnecting piping. Four photo-processors provide the primary load for the system. Each processor input hot water temperature is adjusted by a mixer valve. The valves are set to the temperature requirements of the particular film type being processed, thus vary from time-to-time. Solar-energy-derived hot water is also used in six sinks and two bathrooms in the building.

37129 (SOLAR/2005—77/14) **Solar energy system performance evaluation. Iris Images, interim report.** (International Business Machines Corp., Huntsville, Ala. (USA)). Nov 1977. Contract EG-77-C-01-4049. 47p. Dep. NTIS, PC A03/MF A01.

A detailed performance evaluation, based on instrumented data collected between June 1977 and September 1977, of the Iris Images solar energy system has been completed. During this analysis it was found that excessive losses are occurring from uninsulated pipes and manifolds between the collector and the pre-heat tanks. In addition, it was discovered that the collector controller is unstable in periods of low insolation because its set points are mismatched. A TRNSYS simulation model was developed and used to predict fossil energy savings of 140 million Btu per year. Recommendations were made to insulate the pipes and manifolds to reduce the energy losses and increase system performance. It was also recommended that the collector controller set points be changed to prevent premature failure of the pump. In addition to the recommendations for system changes, it was also recommended that the performance evaluation be continued in order to evaluate the system under a wider range of operating conditions and to validate the simulation model.

WATER HEATING

REFER ALSO TO CITATION(S) 37114, 37119, 37128, 37129

37130 (SOLAR/2016—77/13) **Solar energy system description document. Loudoun County site, Site ID 033, PON 2157.** (International Business Machines Corp., Huntsville, Ala. (USA)). 28 Oct 1977. Contract EG-77-C-01-4049. 17p. Dep. NTIS, PC A02/MF A01.

The solar heating system for the Loudon County site provides solar preheating of the domestic hot water supply for the Charles S. Monroe Vocational-Tehnical School at Leesburg, Loudon County, Virginia. In this area the predominant method of providing hot water has been through the use of fuel-oil water heaters. In the current system solar energy is collected by an array of flat plate modular collector surfaces and transmitted via the collector working fluid to a heat exchanger in a large solar storage preheat tank. The preheated water from the solar storage tank is then supplied on demand to a smaller storage water heater. Additional heat is supplied, if required, by an auxiliary electrical heating element in the storage water heater. A recirculating system is active during normal use hours to keep hot service water availabla immediately at all hot water taps. Cold makeup water enters th solar tank as hot water demand is initiated at any tap. Cold water is also allowed to enter the hot water lines through temperature controlled mixing valves to prevent service water from exceeding the desired temperature. The building is a single story school building used as a vocational-technical training center for older teenage and adult students. The anticipated school population is 350 students. The hot water supply is used in washroom and kitchen facilities, primarily during daylight and early evening hours.

37131 Long term performance of solar assisted water heating systems. Howarth, A.T. *Build. Serv. Eng.;* **8**: No. 45, 147-153(Nov 1977).

A computer simulation of the performance of solar assisted water heating systems has shown that daily total draw off volumes and solar intensities are of greater importance than distributions of draw off and sunshine. A method of predicting long term performance using total draw off volume and mean solar data is developed form the long term energy balance. The method can be used for rapid assessment of economic viability of systems using flat plate solar heat collectors.

37132 Solar building panel concept for the supply of hot water. Spedding, P.L.; Allen, M.L.; Brow, D. *N.Z. Eng.;* **32**: No. 6, 126-131(15 Jun 1977).

An experimental building panel was designed and evaluated for its performance. It was compared to a copper tube, flat plate, single glazed collector and a double glazed solar building panel. The panel was tested with water and air as heat transfer mediums. The building panel acheived temperatures between 60° and 61°C with a 35 to 40% efficiency. The life of the panel is viewed as one of its main problems. With the addition of epoxy tar lining, the life of the collector could be extended to 20 years. The solar building panel can be constructed at $10 to $15/m^2, or one-tenth the cost of the glazed collectors, according to the authors.

37133 Guide to sizing and economics of solar water heating in Florida residences. Subrato, C. Cape Canaveral, FL; Florida Solar Energy Center (1977). vp. .

This is a consumer book explaining the various aspects of a solar water heating system. Two different types of domestic water

heating systems are explained; the open, direct water system and the closed loop or antifreeze systems. The typical flat collector is explained with a diagram of it as well as the absorber tubing construction. Solar water heating components are examined. Sizing of the system is discussed in terms of the hot water demand and the solar system sizing. Graphs are included of Florida climate, collector tilt and orientation. To estimate the economies of the solar hot water system for the homeowner, calculations are made of the solar savings in terms of the long term purchase and the short term purchase. Buying, installation and maintenance tips are included. A bibliography, appendix and glossary of terms are included at the end of the text.

37134 Appraisal of solar water heating in the UK. Courtney, R.G. *Building (London);* **224**: No. 6909, 137-139, 141(1976).

The problems associated with the domestic application of solar energy are discussed. A simple solar water heating system is described; it is estimated that this could supply 40 percent of the annual hot water requirements of the average household. However, cost analyses from the viewpoints of both the nation and the individual householder show that at present the installed cost of such a system is likely to be too high when compared with the cost of the energy saved. At some time in the future, however, solar energy may have a prominent role to play and so research should continue.

SOLAR COLLECTORS AND CONCENTRATORS

REFER ALSO TO CITATION(S) 37058, 37111, 37132

37135 (SAND—77-1641) **Effects of nonuniformities on natural convection in annular receiver geometries.** Hickox, C.E.; Gartling, D.K. (Sandia Labs., Albuquerque, N.Mex. (USA)). Dec 1977. Contract EY-76-C-04-0789. 38p. Dep. NTIS, PC A03/MF A01.

The effects of nonuniform temperature distribution and eccentricity on natural convection heat transfer in a horizontal annulus were assessed through use of a finite element computer program. Calculated results are compared with previously published experimental results. The numerical results indicate that highly nonuniform temperature distributions and large eccentricities are necessary in order to appreciably affect the natural convection process.

37136 (SAND—78-0381) **Performance testing of the Hexcel Parabolic Trough Solar Collector.** Dudley, V.E.; Workhoven, R.M. (Sandia Labs., Albuquerque, N.Mex. (USA)). Mar 1978. Contract EY-76-C-04-0789. 24p. Dep. NTIS, PC A02/MF A01.

The testing performed on the Hexcel Parabolic Trough Solar Collector at the Solar Total Energy Test Facility is summarized. Test objectives are defined, test procedures are described, and results and conclusions are given.

37137 Multi-purpose solar collector/heat exchanger. Worthington, M.N. US Patent 4,068,652. 17 Jan 1978. Filed date 17 Feb 1976. 10p.

A multi-purpose solar collector—heat exchanger is described that is susceptible of usage other than the heating of a house or similar premises. The heat exchanger comprises at least three flat metallic sheets and two sheets having longitudinal grooves therein. One of the grooved sheets is interposed between an outer flat sheet and an intermediate flat sheet. The other grooved sheet is interposed between the intermediate flat sheet and the other of the outermost sheets. Where apexes or bends of the longitudinal grooves meet the flat sheets, they are attached thereto. The flat sheets and grooved sheets cooperate to define a plurality of longitudinal channels. A manifold is integrally joined to the ends of the outermost flat sheets at each end of the exchanger with each manifold having a duct depending therefrom and each duct being adapted to function either as an inlet or outlet for air.

37138 Method for evaluating the solar energy provided by a flat insolator. Gicquel, R. (Center for Mechanics, Ecole Nationale Sup'erieure des Mines, Paris). *Int. Chem. Eng.;* **17**: No. 4, 575-582(Oct 1977).

A solar heating system is broken down schematically into three parts: the distribution network, thermal storage and the collection installation. Flat insolators (collectors) are described. Heat losses from collectors can be attributed to optical losses and thermal losses. Methods for determining the amount of solar energy received by a solar collector are suggested, including measurements carried out by the meteorological services, calculations for an inclined collector, astronomical equations and the measurements of direct and diffuse radiation. Efficiency of the collector is explained in several equations for single and double glazing. Equations are given for overall efficiency. An example is given using the Antibes region for a solar collector with single glazing during the winter season. Results showed that during the winter months, the collectors provided a total energy between 275kWh/m^2 and 295kWh/m^2. Tables show that during the summer months energy provided is 742kWh/m^2. In conclusion, it is stated that the equations used are sufficiently accurate for the solar energy received by the collector and quantity of heat obtained. The possibility of developing collectors with better performance and testing the sensitivities of their efficiencies to variations in the parameters of construction is suggested.

37139 Two-dimensional analysis of a flat plate collector. Prabhakar, R.P.; Francis, J.E.; Love, T. (University of Oklahoma). *J. Energy;* **1**: No. 5, 324-328(Sep-Oct 1977).

A two-dimensional steady-state analysis of a flat plate collector was made. The theoretical studies were undertaken on a winter day at a latitude of 35° and longitude of 97° and at 1300 hr. The incident solar radiation was assumed to be 200 Btu/hr ft^2 with a collector tilt of the latitude plus 15° and an ambient temperature of 50°F, and a wind speed of 5 knots. The results show that for flow rates in normal operating ranges, the axial fluid temperature variation is considered as linear. The model also shows that outlet temperatures increase with increasing tube spacing/tube diameter ratio. Also shown was that the outlet fluid temperature is relatively insensitive to either plate thickness or thermal conductivity within the range of parameters used. It was noted that there was an optimum tube spacing that results in maximum collector efficiency. Beyond a certain value of tube spacing, losses become greater and efficiencies are reduced. For a mass flow rate per unit area of about 10 lb/hr ft^2, the collector reaches its nearest maximum efficiency for that particular configuration. Further increases in the mass flow rate were not responsible for an increased efficiency. The computer model generated can be run using hourly values of atmospheric data making it suitable for simulation work.

37140 Selective surfaces for solar-thermal conversion. Masterson, K. (University of Arizona, Optical Sciences Center). *J. Solid State Chem.;* **22**: No. 1, 41-49(Sep 1977).

A selective surface is defined as one having a high absorbance over the wavelengths spanning the spectrum of solar flux and also a low emittance. The paper reviews the economics of using the selective absorber coating and the basic designs for implementation on flat plate distributed collector and central receiver systems. Equations are used to indicate the relationship between performance and selectivity. Optical characteristics of various optical coatings are discussed. The author identifies five methods for obtaining surface selectivity: (1) single material, (2) bulk absorber-reflector tandem, (3) interference films, (4) controlled surface morphology, (5) resonance absorption of small particles in the dielectric. Selective coatings run from less than $1/m$^{2} to several dollars per square meter.

37141 Optical properties and selective solar absorption of composite material films. Gittleman, J.I.; Abeles, B.; Zanzucchi, P.; Arie, Y. (RCA Laboratories, Princeton, N.J.). *Thin Solid Films;* **45**: No. 1, 9-18(15 Aug 1977).

Selective surfaces used for solar collectors for commercial purposes are mostly composite surfaces. The cermets Au-MgO and W-MgO and the semiconductor-insulator composites Si-CaF_2 and Si-MgO are investigated. Infrared absorption measurements of the cermets deposited on Si or KBr showed the characteristic absorption band of MgO at 25 micrometers. No appreciable reaction takes place between the metals and MgO. For Si-MgO and $SiCaF_2$, strong additional absorption bands were observed. The Maxwell-Garnett theory is used to predict the position of the absorption peaks in the visible characteristics of Au and Ag dispersions. The optical properties for Au-MgO revealed an anomalous structure. W-MgO, with 34% volume W, behaves as a metal; with 28% or less volume W, it behaves as insulators. The refractive indices for Si-CaF_2 did not vary appreciably with the lambdal value. Solar performance is judged by the conversion efficiency. In conclusion, the author states that selective absorbers for high temperature solar collectors have more sensitive requirements. The conversion efficiency is very sensitive to the wavelength emmitance when it exceeds 1.5 micrometers. The higher the operating temperature, the greater the problem of thermal stability. Research of more materials is needed before the photothermal conversion of solar energy at higher temperatures and also with a low concentration factor can become technically feasible.

37142 Solar heat boiler. Kume, T. (to Suehiro Seiki Co., Ltd.). US Patent 4,034,737. 12 Jul 1977. Priority date 21 Jun 1974, Japan. 8p.

A solar heat boiler apparatus has a base frame, a turning body rotatably mounted on the base frame for turning movement about a horizontal axis, a reflector mounting frame rotatably mounted on the turning body for rotation around an axis perpendicular to the horizontal axis, and turning mechanisms coupled to the turning body and the reflector mounting frame for turning the turning body and the reflector mounting frame to direct the reflector mounting frame toward the sun. A plurality of curved mirrors are mounted side by side on the reflector frame in a concave spherical arrangement to form a reflector unit, each curved mirror having, in plain view, the shape of a sector of an annulus and in longitudinal section the shape

of a part of a circle. The mirrors in the arrangement are positioned with the sector shapes on circular lines concentric with the optical axis of the concave spherical arrangement and to reflect rays incident on the reflector unit parallel to the optical axis of the concave spherical arrangement to a focal position on the optical axis. A boiler unit is positioned at the focal position to receive the reflected rays.

37143 Means of increasing efficiency of CPC solar energy collector. Chao, B.T.; Rabl, A. (to Energy Research and Development Administration). US Patent 4,007,729. 15 Feb 1977. Filed date 27 Jun 1975. 6p.

PAT-APPL-590,980.

A device is provided for improving the thermal efficiency of a cylindrical radiant energy collector. A channel is placed next to and in close proximity to the nonreflective side of an energy reflective wall of a cylindrical collector. A coolant is piped through the channel and removes a portion of the nonreflective energy incident on the wall which is absorbed by the wall. The energy transferred to the coolant may be utilized in a useful manner.

37144 Arrays of fixed flat plate solar energy collectors: performance comparisons for differing individual component orientations. Janke, S.H.; Boehm, R.F. *AIChE Symp. Ser.;* 73: No. 164, 171-180(1977).

A determination is made regarding the energy density and flux available after passage of direct solar radiation through single and double glass covers, for panels inclined at various angles and oriented with varying azimuths, several latitudes are also considered. Results of a computer program which for any latitude, date, time of day and arbitrary pannel orientation allows for atmospheric attenuation and glass transmission are displayed in several graphical formats. Orientizations other than south facing are found to give greater availability of energy for a period of roughly 90 days centered about the summer solstice, and to give higher flux values early or late in the day for winter dates, but are inferior to south facing pannels in other respects.

HEAT STORAGE

REFER ALSO TO CITATION(S) 37114

37145 (SAND—77-8512) **Analytical solution for the multidimensional degradation of a packed bed thermocline.** Margolis, S.B. (Sandia Labs., Livermore, Calif. (USA)). Jan 1978. Contract EY-76-C-04-0789. 42p. Dep. NTIS, PC A03/MF A01.

A multidimensional, time-dependent model of the thermocline degradation in a packed bed thermal storage tank is presented. In earlier reports a one-dimensional model, incorporating the effects of heat losses out the ends of the tank, was solved analytically using both separation of variables and transform methods. The multidimensional analysis presented here includes the additional effects of heat losses out of the sides of the tank for the types of boundary conditions of greatest interest, and is thus a more realistic model of the problem. The technique used to solve the coupled pair of partial differential equations describing the degradation of the thermocline is based on a vectorized separation of variables approach. Assuming cylindrical geometry, the analysis leads to separate eigenvalue problems for the radial, angular, and axial spatial dependencies of the fluid and solid temperatures in the bed. The eigenvalues are readily calculated and the corresponding eigenfunctions are shown to form a complete set of spatial basis functions for the solution space. The applicability of the method is illustrated by an example and important conclusions are drawn from the results.

GEOTHERMAL ENERGY

37146 (EPRI-ER—660-SR, pp 6.1) **Workshop: future directions.** Finlayson, V. (Utah Power and Light, Co., Salt Lake City). Jan 1978.

In EPRI Annual Geothermal Program.

37147 (EPRI-ER—660-SR, pp 7.1) **Workshop: EPRO geothermal program plan and direction.** Grant, A. (Portland General Electric Co., OR). Jan 1978.

In EPRI Annual Geothermal Program.

RESOURCE STATUS AND ASSESSMENT

37148 (EPRI-ER—611-SR) **Geothermal energy prospects for the next 50 years.** (Electric Power Research Inst., Palo Alto, Calif. (USA)). Feb 1978. 92p. Dep. NTIS, PC A05/MF A01.

Three facets of geothermal energy—resource base, electric power potential, and potential nonelectric uses—are considered, using information derived from three sources: (1) analytic computations based on gross geologic and geophysical features of the earth's crust, (2) the literature, and (3) a worldwide questionnaire. Discussion is presented under the following section headings: geothermal resources; electric energy conversion; nonelectric uses; recent international developments; environmental considerations, and bibliography. (JGB)

USA

37149 (CONF-770440—, pp 44-51) **Advances in geothermal energy research: an overview.** Kruger, P. (Stanford Univ., CA). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

Geothermal energy has been touted as one of the more promising alternate energy sources for meeting projected U.S. energy demands by the close of this century. And yet very little advance in the development of a geothermal industry is readily apparent, save for the steadily growing Geysers electric power station in California. Much of the problem lies in the complex nature of the vastly unexplored resources of geothermal deposits, which occur in a variety of geologic, thermal, and chemical qualities. Much of the problem lies in the prime emphasis of geothermal development solely as a resource for base-load electricity generating capacity with an energy source that may be more significant for direct heat applications. And much of the problem, in common with other alternate energy sources, lies in the institutional problems created by environmental and regulatory requirements for public acceptance. Research to stimulate the development of geothermal energy is underway in the public and private domains essentially over the entire "fuel cycle" from exploration to utilization. The acceleration of industrial development of the nation's geothermal resources requires parallel advances in the establishment of adequate reserves of commercial-grade resources, demonstrated technologies for utilizing the more abundant lower-grade resources, and resolution of some of the institutional impediments to a cost-effective industry. Significant advances have been made in each of these three major areas of concern. And yet, many more are required before geothermal resources can provide a significant fraction of the nation's energy supply.

37150 (CONF-770440—, pp 562-572) **Evaluation of the geopressured geothermal resources of the Texas Gulf Coast.** Dorfman, M. (Univ. of Texas, Austin); Deller, R.; Bebout, D.; Loucks, R.; Howard, J.H.; House, P.A. 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

Efforts to evaluate the potential contribution to the national energy supply of geopressured geothermal resources in the Gulf Coast have included a program of resource assessment and programs to examine utilization of the resource for the production of electricity and as a source of industrial-process heat. Work on resource assessment has suggested the presence of perhaps as much as 6000 MW-centuries of recoverable electric energy and over 500 Tcf of methane. This program has emphasized finding significantly large sand bodies within the geopressured stratigraphic section in addition to defining the distribution of abnormal fluid pressures and formation temperatures. Regional sand facies analyses conducted thus far indicate several locations in the Frio formation of coastal Texas where adequately large geopressured geothermal resources may be present. Engineering studies of energy-conversion systems based on total-flow, flashed-steam, and binary-cycle concepts show that development of electric power from the Gulf Coast geopressure resource is technically feasible. However, such recovery is only marginally economic in view of the relatively low temperatures involved (less than 300°F or 149°C), and especially if dissolved methane is not present at saturation levels. Under favorable circumstances, investment in exploitation of the complete geothermal resource can produce rates of return of 15 to 30%.

NON-USA

37151 Chinetsu enerugi no kaihatsu riyo. (Geothermal exploration and utilization). Suyama, J. Tokyo; Atomic Energy Society of Japan (1977). 4p. (CONF-770381—1). TIC.

From 15. national symposium on atomic energy; Tokyo, Japan (1 Mar 1977).

Rapid expansion of exploration technology is necessary for the effective exploitation of high quality geothermal reservoirs. The number of geothermal fields being exploited is relatively small, and limited to those areas showing overt signs of geothermal activity such as hot springs and gaseous exhalations. Geothermal energy is an attractive and promising resource in Japan. There are more than 110 hot springs known to possess water temperatures exceeding 90°C. Extensive surveys must be made of the characteristics of geology and distribution of geothermal reservoirs in Japan. Reinjection technology must be developed and methods of hydraulic and explosive fracturing improved to create artificial hydrothermal systems to eliminate the possibility of resource depletion.

37152 Prospects of using thermal power systems for geothermal heating under the conditions of the Dagestan ASSR. Badavov, G.V.; Sultanov, Yu.I. *Sb. Nauchn. Tr. Dagestan. N.-I. Otd. Energ. M-Va Energ. I Elektrifik;* No. 4, 149-164(1975). (In Russian).

Over 50 large-scale geothermal water deposits have been discovered and mapped in the Dagestan ASSR over the last 10 years. More than 80% of the explored geothermal waters have a temperature of from 50 to 80°C. The characteristics are given for 35 exploited wells and consumers. The thermal effiiency of the wells can be increased by using combined systems, for example with a "peak" boiler or heat pump installation. A combined system that covers the base load heating curve with geothermal waters and the peak from electrical energy is more efficient. After the Chirkeyskiy and Miatlinskiy GES's are connected to the combined power grid, there can be excess electrical power on the order of 338 MW and 886 million kW-hr. Part of this energy (9.4 and 13%) can be used during the free part of the electric energy demand curve, although the use could be temporary (5-10 yr).

GEOLOGY, HYDROLOGY, AND GEOTHERMAL SYSTEMS

37153 (EPRI-ER—660-SR, pp 4.39-4.42) **ERDA-DGE/LBL geothermal reservoir engineering management program.** Howard, J.H. (Univ. of California, Berkeley). Jan 1978.

In EPRI Annual Geothermal Program.

Lawrence Berkeley Laboratory (LBL) has been assigned responsibility by ERDA/Division of Geothermal Energy (DGE) for developing and then implementing a plan for support of research in geothermal exploitation engineering. Although historically referred to as REMP (Reservoir Engineering Management Program), the scope of the activity encompasses many aspects of geothermal exploitation engineering; and reservoir engineering (as traditionally defined to include well testing and modeling mass and energy transport) is, in fact, a subset of the whole program. A diagram showing the elements that make up the program is shown. The planning group, on the one hand, develops various draft plans. The review task force, on the other, is responsible for commentary on the drafts and for a statement in general terms regarding the completeness of the plan and the priorities of the tasks identified in the plan. The final form of the plan will incorporate improvements resulting from exchanges between the planning group and review task force. The document will include a statement of all tasks that should be carried out and an assignment of priorities to each of them. The product of all this activity is a document to be used as a guide in supporting research in geothermal exploitation engineering. (JGB)

USA

REFER ALSO TO CITATION(S) 37167, 37171, 38304, 38308, 38309, 38310, 38311

37154 (CONF-770440—, pp 60-67) **Recent developments at the Roosevelt Hot Springs KGRA.** Lenzer, R.C.; Crosby, G.W.; Berge, C.W. (Phillips Petroleum Co., Del Mar, CA). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

The Roosevelt geothermal field, located in southwestern Utah, has been the focus of a high level of activity by both private industry and the academic community. Nine exploration wells have been drilled to depths ranging between 370 and 2300 meters into a late Tertiary granitic igneous complex. The reservoir is confined to fractures within the granitic and metamorphic rocks. The nature of the reservoir is such that all wells drilled are wildcats. The geothermal field lies along the west side of the central Mineral Range. Young rhyolite domes, with associated flows, pierce the late Tertiary granitic complex a few kilometers to the east and south of the producing wells. The heat at Roosevelt is probably supplied by the parent magma for the rhyolite domes. The resource is a water dominated geothermal system with a maximum temperature in excess of 265°C. The water is a sodium chloride water with salinity less than 8000 mg/l. Recent activities include the formation of the Roosevelt Hot Springs Unit, applications to appropriate water from the state, the establishment of a groundwater monitoring system in the valley, and preparation for additional reservoir testing.

37155 (CONF-7504139—, pp 247-270) **Special aspects of cenozoic history of southern Idaho and their geothermal implications.** Warner, M.M. (Boise State Univ., ID). 1975.

From 13. engineering geology and soils engineering symposium; Moscow, ID, USA (2 Apr 1975).

In Engineering geology and soils engineering symposium.

Regional plate tectonics of the Pacific basin are directly related to these features in southern Idaho: basin development, four major geothermal belts, over 200 hot springs and wells, and a large left lateral rift that coincides generally with the present Snake River course. The Snake River rift is indicated by 16 different lines of evidence, 12 of which are offset geologic features, each with a displacement of approximately 50 miles. The regional setting, along with local rifting, Cenozoic volcanism, graben development, thermal waters, much faulting, good reservoir conditions, and abundant surface water and ground water supplies makes southern Idaho an ideal region for geothermal exploration. Fish, mollusk and plant fossils, plus stratigraphic and structural correlation, enables reconstruction of eight chronological events in Cenozoic history, including: an early Tertiary basin, the Snake River graben, two major shifts in the Snake River course, a long period of composite volcanism, late Cenozoic rifting, and great Pleistocene uplift. Calcareous oolites appear to be fair indexes to geothermal anomalies in southern Idaho.

37156 Late Cenozoic Coso volcanic field, Inyo County, California. Babcock, J.W. Santa Barbara, CA; Univ. of California (1977). 257p. University Microfilms Order No. 77-25,591.

Thesis (Ph. D.).

The Coso volcanic field is an area of late Cenozoic volcanism capping the Coso Mountains at the southern terminus of Owens Valley, California. The volcanic rocks include alkaline basalt and subalkaline basalt, olivine andesite, dacite, rhyodacite and rhyolite that were generally erupted from different sources. The volcanic rocks of the Coso volcanic field have been divided into the following units, from oldest to youngest: basalt near Coso Peak, Volcano Butte Dacite, Petroglyph Basalt, Volcanics from the Haiwee volcanic center, Wild Horse Mesa Andesite and the Little Lake Rhyolite. Within the volcanic units there is only minor crystal differentiation with the possible exception of the volcanics from the Haiwee volcanic center. Vents, where exposed, for the volcanic rocks are concentrated along faults or at fault intersections within a regional zone of extension encompassing the entire Coso volcanic field. The Coso volcanic field cannot be characterized as "fundamentally basaltic" or as a simple basalt field but instead it is shown to be a complex field composed of volcanic rocks ranging in composition from alkaline and subalkaline basalt through rhyolite. The source of the basalt and olivine andesite is interpreted to be the mantle. The low K_2O basalts possibly came from a zone of previous melting within the mantle. Volcanic rocks of intermediate and silicic composition are interpreted to be derived from increasing crustal involvement with increasing silica content of the volcanic rocks. The Coso volcanic field is within a zone of extension between two grabens, Rose Valley and Centennial Flat. These two grabens are the bifurcating graben arms of Owens graben where Owens graben splays south of Owens Lake.

NON-USA

REFER ALSO TO CITATION(S) 37169, 37171

37157 Hokkaido ni okeru jobu mantoru no kyu bunpu. (Q-distribution of upper mantle in Hokkaido). Moritani, T.; Nakajima, T.; Okada, H. Tokyo; Seismological Society of Japan (1977). 2p. (CONF-770590—1). TIC.

From Meeting of the Seismological Society; Tokyo, Japan (12 May 1977).

The attenuation of seismic waves from earthquakes of various depths was measured at five observatories on Hokkaido in order to estimate the Q values by S/P techniques. The apparent Qs was between 150 and 200 for earthquakes occurring at a depth of 150 km below Kamifurano. Similar Qs values were obtained at a depth of about 100 km, beyond the volcanic front, as well as at northern Makanbetsu. This indicates that the low-Q zone extends beyond the volcanic front of Hokkaido to the north but not to the southwest. In Sapporo, many short period components from the Uragaoki earthquake demonstrated slightly larger but similar Qs values. Consequently, it can be seen that the regional differences in Qs values coincide with the distribution of crustal heat flow. The crustal heat flow of the Watarijima Peninsula ranges from 3 to 5 HFU. This is two to three times greater than the heat flow of central Hokkaido.

The Qs value below Watarijima is about 70, which is ½ to ⅓ the value below central Hokkaido.

37158 Hokusei taiheiyo chiiki no chikaku netsu ryuryozu no sakusei-Kantaiheiyo mappu purojekuto. (Preparation of a crustal geothermal flow map for the northwest Circum-Pacific area). Ogawa, K.; Kuwagata, H.; Sano, S.; Ueda, S.; Yasui, T. Tokyo; Seismological Society of Japan (1977). 1p. (CONF-770590—2). TIC.

From Meeting of the Seismological Society; Tokyo, Japan (12 May 1977).

For the preparation of a heat flow map of the Circum-Pacific, the area was divided into four quadrants plus the Antarctic continent, each of which was assigned to a separate panel. The inclusion of geophysical information on the geological structure was considered to be of importance and a program was developed in which the numerical values were to be plotted for the appropriate geographical locations. The locations were divided into several ranges on a plane projected by the Lambert equivalent method, using a reduced scale and a given center point. The numerical information was then plotted automatically. Input data was provided by magnetic tape containing heat flow information from WDC-A and an additional data card provided by Yasui. About 300 heat flow values were plotted. By recording digitized coastline data from the US Geothermal Survey Bureau on magnetic tape, a final crustal heat flow map was realized. The devices employed in map production included an IBM 370/145 computer, a Xeinetics plotter and a graphic tablet device provided by the Oil Development Technology Center.

37159 Kishokenkyu sho ni okeru kazan funka yochi no kenkyu. (Meteorological Research Institute studies of volcanic eruption prediction). Tokyo; Meteorological Research Institute (1977). 13p. (NP—22483). TIC.

Aerial topographic and geothermal surveys were made of the craters of Sakurajima-Minamidake and Asosan-Nakadake. An infrared image device (DS-1250 MSS) was used. Electro-optical distance measurements were also performed at the craters of Miharayama and Asamayama. At Sakurajima, the hottest geothermal anomaly was found, having a value of 39°C. At Asosan, the anomaly is distributed within the Northern half of the Nakadake crater and has a temperature of 45°C. After comparison of temperature measurements made during 1974 and 1975, it was noted that the temperature has risen at Sakurajima and has fallen at Asosan.

37160 Seismometrical observation in Hakone Volcano, 1976. Ito, H.; Hakamata, K.; Hiraga, S. (Hot Spring Research Inst., Kanagawa, Japan). *Bull. Hot Spring Res. Inst., Kanagawa Prefect.;* **8**: No. 1, 1-16(1977). (In Japanese).

The seismic activity of the Hakone Volcano in the period from January to December 1976 was very calm and only 24 microearthquakes with (s-p) time interval less than 2 sec were recorded. Earthquakes with (s-p) time interval less than 5 sec recorded at Hakone Volcano Observatory amount to 284. The Eastern Yamanashi Prefecture Earthquake took place on June 16, 1976 and a sequence of foreshock-mainshock-aftershock was recorded at Hakone Volcano Observatory.

37161 Continuous observation of temperature and water-level in Hakone Volcano, 1976. Hirota, S.; Odaka, S. (Hot Spring Research Inst., Kanagawa, Japan). *Bull. Hot Spring Res. Inst., Kanagawa Prefect.;* **8**: No. 1, 17-26(1977). (In Japanese).

This is a 1976 annual report of the continuous observation of temperature at 9 stations and water levels at 6 stations. Temperature of thermal water one of the drill-wells at Gora, has dropped down to 71°C from 90°C since July, 1976. Thermal water discharge of wells No. 68 and No. 18 at Sokokura has been decreased by 11 percent and 18 percent respectively. The annual decrease of thermal water-level at the Yumoto area has been accelerated by 1.3 m/year since 1974 by over discharge.

37162 Temperature and thermal discharge of newly appeared steaming ground, Owaki-dani, Hakone. Hirota, S.; Awaya, T.; Oyama, M.; Oki, Y. (Hot Spring Research Inst., Kanagawa, Japan). *Bull. Hot Spring Res. Inst., Kanagawa Prefect.;* **8**: No. 1, 27-38(1977). (In Japanese).

Geothermal activity of a newly appeared steaming ground 300 m east of the Owaki-dani parking lot is getting more pronounced yearly. The area of temperature anomaly of 1977 encircled by 20°C isotherm is 3.24×10^3 m² and by 90°C is 1.66×10^3 m² which are 31 percent and 42 percent larger than those observed in 1973, respectively. The highest temperature observed at 50 cm deep is 97.5°C. T he maximum hydrogen sulfide in steam is 1500 ppM. The thermal discharge from the steaming ground amounts to 1.60×10^6 cal/sec, which is roughly corresponding to 9.6 percent of the total thermal discharge from the Owaki-dani solfataric areas.

37163 Hot springs in Hakone-Yumoto, Kanagawa Prefecture. I. Annual variation of chemical components and temperature of Soyu, a hot spring in Hakone-Yumoto. Hirano, T.; Oki, Y.; Hirota, S.; Ozawa, K.; Ogino, K. (Hot Spring Research Inst., Kanagawa, Japan). *Bull. Hot Spring Res. Inst., Kanagawa Prefect.;* **5**: No. 2, 31-43(1974). (In Japanese).

Annual changes of "Soyu", one of the oldest hot springs in Hakone-Yumoto, are described. The thermal water discharge from fracture of the basement rocks of Hakone volcano is decreasing in chemical components and temperature. It is suggested that this phenomenon is closely connected with the appearance of many deep wells. Temperature of the spring had been at about 52°C and total dissolved salts at 658 mg/l until 1952. Since 1953, dissolved salts and temperature of this hot spring have been reduced, and now are measured at 34.7°C and 412 mg/l. The decrease in temperature and dissolved salts are explained by the mixing of cold groundwater and thermal water, caused by reduction of the water table of the hot spring system, depending on the over-discharge of thermal waters by deep wells.

37164 Pumping tests in the Yumoto-Tonosawa region. Oyama, M.; Kubodera, K.; Iwata, Y. (Inst. de la Source Thermale de la Prefecture de Kanagawa, Japan). *Bull. Hot Spring Res. Inst., Kanagawa Prefect.;* **5**: No. 2, 44-58(1974). (In Japanese).

The Yumoto-Tonosawa region, situated to the east in the Hakone caldera, can be considered as a basin of subterranean waters. The total discharge of the thermal waters of the drilled wells and of the calorific energy are constantly increasing from one year to the next and are kept high at 8.06×10^3 m³/day and 3.02×10^8 kcal/day. Pumping tests were made for investigations on the hydrologic balance in this basin. The first tests were made in five wells along the Sukumo River. As all the wells are compressed air exhaust pumps, the change of height of the water with the pressure of the air reservoir was estimated. The self-pressure change of the exhaust pump, the ratios between the pumping output and the water height, and the intermittent flow of waters into the pumping conduit were examined in particular. The transmissibility coefficients determined by the Theis equation are 1.51×10^{-4} approximately 2.3×10^{-5} m²/sec. Wells No. 56 and 80 (10^{-4} m²/sec) are near a west-northwest to east-southeast fault which controls the movement of underground thermal waters in this region.

GEOTHERMAL EXPLORATION AND EXPLORATION TECHNOLOGY

GEOPHYSICAL TECHNIQUES AND SURVEYS

REFER ALSO TO CITATION(S) 37157, 37159, 38304, 38307

37165 (CONF-770440—, pp 264-269) **Exploration heat flow: comparison of divided-bar and needle-probe thermal conductivity data.** Axtell, L.H. (Geothermal Services, Inc., San Diego, CA); Quiett, S.; Combs, J.; Stolzman, R.A.; Ramo, A.O. 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

Thermal conductivities were obtained on solid cores of several rock types as well as numerous suites of drill cuttings. Divided-bar determinations were made on the solid cores; then, these cores were crushed to powders and measured using the divided-bar cell and the needle-probe techniques. Measurements corrected for water saturation showed excellent agreement among the three techniques with an average difference of less than a few percent. The largest variations in thermal conductivity are low values produced by cores that are not completely saturated, low values from improper porosity corrections in needle-probe determinations, and high values associated with some of the needle-probe determinations. The latter high values are most likely caused by heat losses due to the inability to accurately determine the heat input Q_0 in the approximation of an infinite line source. Reliable thermal conductivity determinations can be achieved more rapidly and easily with unconsolidated materials than with solid rocks. Utilizing a recently developed field portable needle-probe apparatus, on-site thermal conductivity values can be obtained from drill cuttings in less than ten minutes.

37166 (CONF-770440—, pp 529-540) **Drilling results from the eastern Long Valley caldera.** Smith, J.L.; Rex, R.W. (Republic Geothermal, Inc., Santa Fe Springs, CA). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

The Long Valley No. 66-29 geothermal test well was drilled to a total depth of 6920 feet (2109 m.) at a location just east of the northern extension of the Hilton Creek fault, within the Long Valley caldera, California. At total depth the well is at the base of the Bishop tuff, which is here overlain by 1185 feet of post caldera rhyolite tuffs and 1100 feet of younger near-surface sediments. Temperature surveys in the well indicated a shallow-depth maxi-

mum of 158°F (69.9°C) at 998 feet, an intermediate-depth minimum of 114°F (45.4°C) at 4200 feet and a bottom hole temperature of 162°F (72.0°C). A large number of fracture zones were intersected by the well. Analyses of formation water samples obtained by a drill stem test of the 5056 to 5295 feet interval indicate the reservoir to have about 1140 mg/l total dissolved solids. The calculated chemical geothermometer temperature is approximately 384°F (196°C), which is similar to results obtained from published analyses of local hot springs waters. In light of the well data, the published results of the many geophysical exploration surveys previously conducted within the Long Valley caldera were evaluated, and it was concluded that here the different electrical resistivity and seismic noise methods are too dominated by near-surface conditions to be of benefit for resource evaluation.

37167 (CONF-770440—, pp 551-561) **Evalution of geothermal exploration techniques in northern Nevada.** Wollenberg, H.A.; Goldstein, N.E. (Univ. of California, Berkeley). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

Field studies have been conducted at potential geothermal resource areas in north-central Nevada. The purpose of the program was to develop and evaluate techniques to assess the viability of liquid-dominated hydrothermal systems. An integrated program of geologic, geophysical, and geochemical surveys, combined with heat flow measurements, was conducted in Buffalo, Grass and Buena Vista valleys. Geophysical techniques included gravity and magnetics, and active and passive electrical surveys to detect contrasts in electrical resistivity. Active and passive seismic surveys were also conducted. Geochemical samples of hot and cold springs were analyzed by x-ray fluorescence for major elements which provide chemical geothermometers. Samples were also analyzed by neutron activation for trace and radioelements whose abundances may help to disclose hydrologic pathways. In Basin-and-Range type geothermal occurrences, dominated by deeply penetrating fault zones, techniques which most directly illuminate their structural, hydrologic, and thermal settings are geologic mapping, active seismic surveys, chemical geothermometry, and detailed heat-flow surveys. Results of these and electrical, gravity, and magnetic surveys may then be combined to locate sites for deep confirmatory drill holes.

37168 (CONF-770440—, pp 573-582) **Correspondence between heat flow and telluric electric field anomalies in the Imperial Valley, CA.** Maas, J.P.; Humphreys, E. (Univ. of California, Riverside). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

Extensive measurements of the telluric electric field were made over two geothermal anomalies in California's Imperial Valley. Data from the Mesa geothermal anomaly were evaluated, and data from the Salton Sea anomaly are in the process of evaluation. It is concluded that both geothermal areas are coupled with associated anomalies in the telluric electric field. The contrast between relative ellipse area inside and outside of the thermal zones is of the same order of magnitude as the contrast in electrical resistivity shown by shallow Schlumberger soundings. Both of the geothermal areas could have been located by telluric prospecting techniques.

37169 (NP—22330) **Annual information on development and utilization for geothermal energy in Japan.** Iga, H.; Baba, K. (Japan Geothermal Energy Association, Tokyo). 1975. 16p. Dep. NTIS (US Sales Only), PC A02/MF A01.

Japan's geothermal power plants are characerized by high load factors; in 1975 four plants produced 3.64 x 10^8 kWh. The Hatchobaru plant under construction will produce 50 MW utilizing two-phase steam transmission, a horizontal field synchronous generator, radial impulse and a reaction flow double pressure turbine. The incomplete Kakkonda plant will produce 50 MW with an air cooled generator and four stage double flow turbine. Kakkonda will use inclined drilling and air drilling below 800 meters, production and reinjection wells will be ganged at 5—10 meter distance. Thirteen districts were surveyed in FY1975 for heat discharge, hydrothermal alteration, geochemistry, gravity, geology, seismicity and electrical resistivity. A detailed resistivity survey was made in eleven areas, and vegetation, gases and thermal waters were carefully surveyed due to environmental concerns. Mt. Kurikoma was surveyed by private corporate interests. The survey items given greatest weight were environmental considerations and those related to the development of multipurpose use planning for geothermal waters. Cooperation with foreign countries was evidenced by participation in United Nations and other international symposiums. Export of Japanese geothermal equipment is growing, with sales to El Salvador, Iceland, Mexico, the Philippines and the USA.

37170 **Geophysical prospecting methods.** Waters, K.H.; Rice, G.W. (to Continental Oil Co.). US Patent 4,065,749. 27 Dec 1977. Filed date 26 Jul 1976. 52p.

A method is presented for deriving seismic information from over a relatively large expanse of land to determine relevant strike, dip, velocity and related information. The method consists of the utilization of a plurality of strike, dip, velocity (SDV) cross patterned source-receiver arrays disposed at spaced known locations over a selected terrain, thereafter to derive localized and offset seismic data relative to selected pairs of groups of the SDV cross patterns with further signal processing to smooth and integrate strike, dip and velocity information over a specific substratum. The method utilizes information as derived from each SDV cross pattern, as well as offset seismic signal information derived from source/receiver combinations spanning two selected SDV cross patterns.

GEOCHEMICAL TECHNIQUES AND SURVEYS

REFER ALSO TO CITATION(S) 37163, 37167

37171 **Stable isotope studies of some active hydrothermal systems.** Lambert, S.J. Pasadena, CA; California Inst. of Tech. (1976). 387p. University Microfilms Order No. 76-6,533.

Thesis (Ph. D.).

Measurements of $^{18}O/^{16}O$, $^{13}C/^{12}C$ and D/H ratios were made on rocks and minerals from wells drilled in active hydrothermal systems. Samples from four active hydrothermal systems were analyzed: The Geysers, western Mayacmas Mountains, California; Valles Caldera, northern Jemez Mountains, New Mexico; Heber Geothermal Anomaly, Imperial Valley, California; the Tiwi area, Luzon, Philippines. The Geysers, a vapor-dominated hydrothermal system, is developed in Franciscan host rock which contains veins of quartz and calcite whose delta^{18}O values record the temperatures and isotopic compositions of fluids which prevailed during at least two different episodes of rock-fluid interaction. The first episode took place at about 200°C, during which marine silica and carbonate apparently interacted with ocean water entrapped in the sediments to form veins of quartz and calcite whose delta^{18}O values were around 19‰ and 16‰, respectively. The second episode in part recorded by cogenetic vein quartz and calcite delta^{18}O values 4 to 6‰ and 1 to 3‰, respectively, began with large quantities of meteoric water circulating in fractures in the rock at temperatures of 160 to 180°C in response to the Pliocene Clear Lake magmatism. The other three areas contain hot-water systems, noteworthy of which is the Valles Caldera, an accumulation of previously hydrothermally unaltered porous sediments andpumiceous volcanic tuffs. Large volumes of meteoric water have interacted with the rock at various temperatures (100 to 280°C), indicated by changes in calcite, quartz and whole-rock delta^{18}O values in the Caldera. The shallower, little-altered rocks in the Caldera contain calcite and dolomite whose delta^{18}O values suggest they were deposited in a fresh-water lake.

37172 **Calcium carbonate deposit of Yugawara Hot Spring.** Awaya, T.; Hirano, T.; Suzuki, T. (Hot Spring Research Inst., Kanagawa, Japan). *Bull. Hot Spring Res. Inst., Kanagawa Prefect.;* **5**: No. 2, 67-80(1974). (In Japanese).

Most thermal waters of the Yugawara Hot Spring precipitate calcium carbonate. PCO_2 and pH of deep thermal waters were calculated theoretically. PCO_2 is 0.5 to 1.0 ($10^{-0.34}$ to $10^{0.01}$) atm, and pH is 6.2 to 6.4 for the thermal waters with much precipitation of calcium carbonate, whereas PCO_2 is 0.003 to 0.01 ($10^{-2.46}$ to $10^{-1.99}$) atm and pH is 6.9 to 7.7 for the thermal waters with no precipitation of calcium carbonate. As the thermal waters are discharged by air lift pump, PCO_2 decreases down to 0.0003 ($10^{-3.5}$) atm (equilibrium to atmospheric air) and pH of the waters increases up to 7.7 to 8.4. Precipitation of calcium carbonate is accomplished by decreasing PCO_2 and increasing the pH.

EXPLORATORY DRILLING AND WELL LOGGING

REFER ALSO TO CITATION(S) 37154

37173 (CONF-770440—, pp 68-76) **Energy extraction and reservoir management of a moderate temperature hydrothermal system.** Kunze, J.F. (Idaho National Engineering Lab., Idaho Falls); Witherspoon, P.A. 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

Beginning in January, 1975, deep drilling for geothermal water began in the Raft River Valley of south-central Idaho, 6 miles north of the Utah border. Three wells have been drilled, all of which have produced water from a reservoir(s) at measured temperatures of 148 to 149°C, as predicted by geochemical studies. Sustained artesian flows have been in the range of 600 gallons per minute (38

liters/sec) or higher for days at a time. Artesian well head pressures are typically 10 to 11 atmospheres with a hot water column, 3 to 5 atmospheres with a cool water column. To date, logging methods during drilling are inadequate to tell exactly where the resource is. The producing zones in the wells have been inferred indirectly from temperature profiles taken after the reinjection of cool water. Further attempts at use of flow meters will be made. (JGB)

37174 (COO—4081-1) **Development of passive electronic components for instrumentation of improved geothermal logging tools and components. Semiannual progress report. Report No. 1.** Raymond, L.S.; Hamilton, D.J.; Kerwin, W.J. (Arizona Univ., Tucson (USA). Solid State Engineering Lab.). 20 Apr 1977. Contract EY-76-S-02-4081. 31p. Dep. NTIS, PC A03/MF A01.

Research progress is reported on the development of passive components, resistors, capacitors, metallization, and passivation, that will withstand well logging temperatures to 500°C and have extremely low temperature coefficients. The lower the temperature coefficients, the more exacting the instrumentation designs can be without elaborate compensation techniques. The method of fabricating the thin film components is that of chemical vapor deposition (CVD) which is a major deviation from the standard approach. The films are grown in a CVD reactor by passing various reactant gases over a heated substrate. The reactor was modified in order to accommodate the gases needed in the deposition of metals. The reactor can be operated over a temperature range of 400°C to greater than 1200°C, and at any pressure between atmospheric and 1 x 10^{-3} torr. Tungsten, tungsten-silicon, and silicon nitride were successfully deposited on oxidized silicon wafers. The tungsten is used for interconnects and capacitor plates, tungsten-silicon is used as a high resistivity material for resistors, and silicon nitride is used as a dielectric for the capacitors and as a passivation layer. The materials are currently being studied in terms of their deposition parameters and electrical characteristics.

ECONOMIC AND FINANCIAL ASPECTS

37175 (EPRI-ER—660-SR, pp 5.1-5.2) **Pricing of geothermal energy: workshop panel report.** Kruger, P. (Stanford Univ., CA). Jan 1978.

In EPRI Annual Geothermal Program.

The panel convened to review the various philosophies and approaches to the pricing of geothermal energy for the generation of electric power. One approach suggests that the price of energy delivered to a geothermal plant should be dependent on the thermodynamic properties of the fluid as well as such factors as reliability of supply and price of other available fuels. The price could be determined by the net quantity of heat delivered (e.g., in millions of Btus above some negotiated reference temperature). This method puts the cost of energy to the utility in the same framework as other fuels and encourages the utility to improve its efficiency in terms of the number of geothermal Btus required per kWh. An alternate concept considered pegging the price of geothermal energy to a stable resource, such as coal, in order to allow for changes in generating efficiency over the life of the "fuel" contract. A third concept, for pricing geothermal fluids, especially for the more technically uncertain hot-water resources, is adaptation of the pricing policy used at The Geysers steam field, in which the return to the supplier is determined by formula of the costs of alternate fuels available to the utility, adjusted for the differences in plant costs. A fourth concept is making the geothermal resource producer responsible for the generation of electricity, in which the price of the electricity at the busbar becomes the subject of the negotiation between supplier and utility. A fifth alternative among these field-plant relationships is for the utility to purchase part or full ownership of the geothermal resource. The possibility of government-regulated pricing is also considered. (JGB)

37176 (EPRI-ER—660-SR, pp 5.3-5.5) **Busbar contracts for geothermal.** Bell, H. (Arizona Public Service Co., Phoenix). Jan 1978.

In EPRI Annual Geothermal Program.

A relatively simple and convenient method for a utility to obtain geothermal electric power is to buy it as busbar power. In this situation, the utility contracts with a developer/supplier of geothermal power who has taken all of the risks of developing and producing the power and then simply sells it as busbar power. In this case, the utility can be relieved of the responsibilities of operating in areas in which it may not be familiar and of making capital outlays in the areas of high risk. The interaction with state and federal regulatory agencies relative to the cost of the resource and its utilization may also be simplified. Generally, the contract is based on a take-or-pay basis, contingent upon a reasonable geothermal energy source being found and developed. This method could be useful to the utility short in capital or with little experience in the production and conversion of geothermal energy and useful to the producer who can manage the production/conversion cycle with greater efficiency. (JGB)

37177 (EPRI-ER—660-SR, pp 5.7-5.11) **Estimating the value of a geothermal resource to an electric utility.** Corrigan, A.E. (Portland General Electric Co., OR). Jan 1978.

In EPRI Annual Geothermal Program.

The decision of an electric utility to accept a particular price for a geothermal resource depends on the "value" placed upon that resource by the utility. This "value" includes a variety of factors, some of which consist of different portions of the cost or price of the resource, but many of which are not directly related to the cost of the resource, and some of which are intangible and thus difficult to quantify. A decision whether or not to invest in a geothermal resource would depend upon all of these factors. The facts considered by a utility in evaluating and comparing alternative sources of electricity are presented and an evaluation of geothermal energy is given with a view toward identifying some of its advantages and disadvantages, and some of the difficulties that would have to be resolved in a pricing arrangement. With full or part ownership of the geothermal resource, the utility has greater control over resource development and availability, but incurs greater risk. (JGB)

37178 (EPRI-ER—660-SR, pp 5.13-5.17) **Considerations for the pricing of geothermal energy.** Dolan, W.M. (AMAX Exploration, Inc., Denver). Jan 1978.

In EPRI Annual Geothermal Program.

It is suggested that the price of geothermal energy be pegged to a stable resource, such as coal, in order to allow for changes in generating efficiency over the life of the "fuel" contract. Provisions for reduced or improved performances, such as changes in fluid enthalpy or turbine efficiency, would be added to allow the producer and the utility to share in the resultant change in total electricity cost. A formula to relate such changes relative to the cost of producing electricity by coal was proposed. (JB)

37179 (EPRI-ER—660-SR, pp 5.19-5.20) **Few thoughts on pricing geothermal energy.** Falk, H.W. Jr. (Magma Power Co., Los Altos, CA). Jan 1978.

In EPRI Annual Geothermal Program.

A method suggested for pricing geothermal fluids, especially for the more technically uncertain hot-water resources, is adaptation of the pricing policy used at the Geysers steam field, in which the return to the supplier is determined by formula of the costs of alternate fuels available to the utility, adjusted for the differences in plant costs. Under such a contract the return (in mill/kWh) is determined by the output and efficiency of the plant, which would be required to be operated as close to full capacity and as continuously practical. (JGB)

37180 (EPRI-ER—660-SR, pp 5.21-5.24) **Pricing of geothermal energy.** Greider, B. (Chevron Resources Co., Larkspur, CA). Jan 1978.

In EPRI Annual Geothermal Program.

The price of energy delivered to a geothermal plant should be dependent on the thermodynamic properties of the fluid as well as such factors as reliability of supply and price of other available fuels. The price could be determined by the net quantity of heat delivered (e.g., in millions of Btus above some negotiated reference temperature). This method puts the cost of energy to the utility in the same framework as other fuels and encourages the utility to improve its efficiency in terms of the number of geothermal Btus required per kWh.

37181 (EPRI-ER—660-SR, pp 5.25-5.26) **Comments on pricing of geothermal energy.** Fick, T.R. (Bechtel Corp., San Francisco). Jan 1978.

In EPRI Annual Geothermal Program.

A study that included the effects on power plant design and busbar electric energy costs of the anticipated decline in geothermal brine temperature of the Heber reservoir was concluded. A two-stage flashed-steam energy conversion process was used, and two operating modes, constant brine flow and constant power output, were considered. Plant net capacities were taken at 50, 100, and 200 MW(e) as multiples of 50 MW(e) units. The "cost of fuel" was estimated as a direct function of the cost of developing and operating the well field, including the cost of drilling more wells as the reservoir cools with time. Any connection between previous less direct costing bases, such as the cost of oil or nuclear fuel, was avoided. Capital costs for the well field and the power plant were estimated by the usual methods. Cost and power plant energy output were both expressed in levelized annual terms, and a plant capacity factor of 85% was assumed. Results emphasize that realistic "cost of fuel" and the effects of reservoir temperature decay are important and should be included in the pricing of geothermal energy.

37182 **Evaluation of geothermal energy potential.** Sapre, A.R. Stillwater, OK; Oklahoma State Univ. (1974). 156p. University Microfilms Order No. 78-01,371.

Thesis (Ph. D.).

The objective of this study is to assess the cost of power generated by using "low grade" geothermal energy existing under a variety of naturally occurring conditions. It is also proposed to study the effect of some design variables and natural surroundings on the cost of power. The "low grade" geothermal energy as defined for this study is the geothermal energy available in the areas where the temperature gradient is between 2°F and 5°F per 100 feet. The assessment of the cost of geothermal power is accomplished via development of a techno-economic model for the total system. The development of the model is divided into two parts. First, a mathematical model of the system is developed and then a compatible economic model is built for the cost evaluation. A set of data is then used to arrive at the cost of geothermal power by using the techno-economic model. Using the techno-economic model of the geothermal power system, the cost of geothermal power is assessed to be between 1.2 cents/KWH and 4.9 cents/KWH. This large variation in cost is due to the change in the selection of the design of the power generation system and also due to the varying natural environment.

ENVIRONMENTAL ASPECTS AND WASTE DISPOSAL

REFER ALSO TO CITATION(S) 37169, 37194

37183 (CONF-770440—, pp 89-101) **Hydrogen sulfide removal from geothermal steam.** Brown, F.C.; Harvey, W.W.; Warren, R.B. (EIC Corp., Newton, MA). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

The process described entails the removal of hydrogen sulfide from geothermal steam by precipitation in advance of the turbine generator. For the purpose, a scrubber column is employed with a recirculating countercurrent flow of dilute copper sulfate solution. Laboratory (to 200 lb/hr steam flow) and field (1000 lb/hr) trials showed that hydrogen sulfide is removable at a steam-phase mass transport limited rate and that hydraulic conditions in the column can be adjusted to achieve over 90 percent removal. Significant removals of ammonia and boric acid occurred as well, with negligible degradation of steam quality. The copper sulfide precipitate consisted of tight aggregates of fine ultimate particle size and settled rapidly. Its reactivity toward oxidation makes possible its quantitative reconversion to copper sulfate by a mild pressure leach. In addition to scrubbing, liquid/solid separation and regeneration, results of corrosion and materials testing are described. Information is included on the successful outcome of a recent field test at The Geysers, and the process engineering and design for a larger geothermal steam scrubber is outlined.

37184 (CONF-770440—, pp 221-232) **Removal of hydrogen sulfide from simulated geothermal brines by reaction with oxygen.** King, J.E.; Wilson, J.S. (Dow Chemical U.S.A., Freeport, TX). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

The approach taken was to prepare simulated geothermal waters and test the oxidative process over a range of temperatures. The oxygen was injected in controlled quantities into a flowing stream of the hot brine. A reaction zone with a five-minute residence time was provided, with sampling points at one-minute intervals to follow the course of the reaction. Corrosivity of the water was measured before and after the oxygen injection. The hot brine stream was disposed of through a 2-flash, 2-condenser system to reduce the temperature of the liquid being released to less than 100°C. Four principal tasks were carried out. These are as follows: (1) Determination of optimum oxygen-sulfide mole ratio to most effectively remove the hydrogen sulfide while still avoiding the presence of excess oxygen and the resulting extreme corrosivity. (2) Establish the temperature dependence of the reaction and estimate completion time at various temperatures and optimum oxygen-sulfide ratio. (3) Examine effects of dissolved solids content upon the rate of reaction with special emphasis on possible catalytic properties of heavy metal ions which are present in trace quantities in most geothermal fluids. (4) Determine the effects of variables such as pH and the presence of ammonia and/or the presence of sulfate ions on the reaction. Results indicate that the injection of oxygen appears to be a viable method of eliminating the hydrogen sulfide problem in geothermal waters.

37185 (DOE/EDP—0014) **Environmental Development Plan (EDP). Geothermal energy systems, 1977.** (Department of Energy, Washington, D.C. (USA)). Mar 1978. 63p. Dep. NTIS, PC A04/MF A01.

The Geothermal Energy Systems Environmental Development Plan (EDP) identifies the environmental, health, safety, social, and economic issues which are associated with the development, demonstration, and commercialization of geothermal resources and conversion technology. The EDP also describes the actions and implementation strategy required to resolve the issues identified. These actions may include the initiation of R and D activities, operations monitoring, baseline characterization studies, or activities leading to the development of standards and criteria in concert with other responsible agencies.

37186 (NP—22616) **Report of investigation of hot water reinjection problems in the Takinogami geothermal field.** (Japan Geothermal Energy Association, Tokyo). Nov 1975. 7p. (In Japanese). TIC.

A meeting of the Japan Geothermal Energy Association was held in October of 1975. Its purpose was to collect the opinions of members on the topic of reinjection. In general, no adverse effects were reported regarding the reinjection of hot water or steam. It was recommended that care be exercised when drilling reinjection wells in faulted strata in order to prevent the resurfacing of the injected fluid. Reinjection wells are generally designed to penetrate the Kumitoge formation, where the fluid is reheated and returned to the production wells. It was concluded that reinjection is an excellent method for disposal of excess water and steam.

BY-PRODUCTS

REFER ALSO TO CITATION(S) 37027

GEOTHERMAL POWER PLANTS

REFER ALSO TO CITATION(S) 37152, 37169

DESIGN AND OPERATION

37187 (CONF-770440—, pp 52-53) **Start-up and test operation at the SDG and E/ERDA Niland Geothermal Loop Experimental Facility.** Lombard, G.L. (San Diego Gas and Electric Co., CA). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

A nominal 10 Megawatt Geothermal Loop Experimental Facility was constructed near the Salton Sea. Operations were initiated in May, 1976, after two months of system check-out testing. During the start-up operations several modifications were made to the steam/condensate systems and the brine system controls. Scale deposits were successfully cleaned from the brine reinjection system and other brine-handling piping. The reinjection pump performance has been better than expected and a solution has evolved which extended the bearing life in this severe environment. Nearly one year of operational experience has been generally very successful. The thermal energy of the high salinity, high temperature resource has been successfully extracted. Simplified control and handling of the brine and flashed steam/condensate has allowed: scale to be removed, plant operators to anticipate problems, and limited maintenance costs. Plant modifications have included replacement of on-off controls with proportional elements, revised pump bearings, and replacement of modifications to valves.

POWER PLANT SYSTEMS AND COMPONENTS

37188 (CONF-770440—, pp 251-262) **Field test plan for the helical screw expander.** McKay, R.A. (Jet Propulsion Lab., Pasadena, CA). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

Preparations are under way to test the helical rotary screw expander in a 1250 kVA power system under wellhead conditions at selected liquid-dominatee geothermal fields. The test plan provides for throttling and fractionating the feed to the expander in order to simulate a wide range of wellhead pressures and steam quality. Provision is also planned to vary the expander exhaust pressure. The main focus of the performance evaluation will be the determination of the engine efficiency, which shows how well the actual expander compares with an ideal one. The actual work done by the expanding fluid will be compared with the ideal expansion work equal to the isentropic expansion from the same inlet to exhaust conditions. For this purpose the shaft output power and the pertinent fluid properties

and flow rates will be measured. Efficiency determinations within +-3 percent are predicted. The test plan, including process schematic, measurement requirements, and uncertainty analysis, is discussed. As part of the test philosophy, a test process was devised which is readily adaptable to one candidate scheme for commercial wellhead power system utilization.

37189 Power generating system employing geothermally heated fluid. Shields, J.R. (to Carrier Corp.). US Patent 4,063,417. 20 Dec 1977. Filed date 4 Feb 1976. 6p.

Geothermally heated fluid is supplied to a nozzle of the first stage of a hydraulic turbine. The water constituent of the geothermally heated fluid is directed by the nozzle against the wheel of the hydraulic turbine to cause the wheel to rotate. A first generator is coupled to the wheel whereby rotation of the wheel results in the generation of electricity. A portion of the geothermally heated fluid passing through the nozzle flashes to a vapor phase. The vapor is delivered to the first stage of a vapor driven turbine. The vapor passes through the wheel of the turbine which results in rotation thereof. A second generator is coupled to the wheel of the vapor driven turbine whereby rotation of the wheel results in additional generation of electricity.

37190 Power producing system employing geothermally heated fluid. Shields, J.R. (to Carrier Corp.). US Patent 4,063,418. 20 Dec 1977. Filed date 4 Feb 1976. 6p.

A power producing system includes a source of geothermally heated fluid having inorganic salts dissolved therein. The fluid is directed through a first direct contact heat exchanger in heat transfer relation with a working fluid of a type insoluble in a liquid including inorganic salts. The vaporous working fluid thus produced is expanded through a prime mover and then directed through a second direct contact heat exchanger. The vaporous fluid is condensed in said second direct contact heat exchanger by passing in heat transfer relation with a relatively cold heat exchange medium comprising a liquid brine solution. The condensed working fluid is thereafter returned to the first direct contact heat exchanger for repeated reuse in the cycle. Inorganic salts are mixed with either the geothermal heated fluid or the relatively cold heat exchange medium to maintain the percentage by weight of inorganic salt in each of the fluids above a predetermined value to prevent the working fluid from being absorbed therein.

GEOTHERMAL ENGINEERING

DRILLING TECHNOLOGY AND WELL HARDWARE

37191 (CONF-770440—, pp 804) **Utilization of melting techniques for borehole wall stabilization.** Altseimer, J.H. (Los Alamos Scientific Lab., NM). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

A research program on the subterrene concept based on excavation by melting was completed recently. Theoretical and experimental studies were made for a broad range of applications. Most recently, a study of subterrene deep geothermal well production systems predicted that, compared to rotary-drilled wells, significant cost savings are possible, e.g., 2 and 4 million dollars for 10-km-deep wells and geothermal gradients of 25 and 40 K/km, respectively. It was also concluded that for most wells the rate of penetration of the melting bits should be increased several times over that attained in the subterrene tests. However, other improvements in the field of borehole sealing and stabilization may be easier to achieve and would be applicable to any type well. Subterrene melting penetration tests showed that borehole glass liners can be formed in a wide variety of materials and structural characterization tests showed that tuff glass cylinders can be many times stronger in compression than the parent material. Also, the tests showed that the rock-glass liner permeability decreases rapidly with confining pressure. New melting devices are conceivable that scould line rotary-drilled boreholes with rock glass or other materials with resultant improvements in well costs. With emphasis on borehole liners, this paper presents an overview of interesting Subterrene program results, data on rock-glass liners, and suggestions on how molten materials might be applied to the borehole wall as part of a rotary drilling operation.

37192 (COO—2677-12) **Adaptation of jet accumulation techniques for enhanced rock cutting.** Mazurkiewicz, M.; Barker, C.R.; Summers, D.A. (Missouri Univ., Rolla (USA). Rock Mechanics and Explosives Research Center). [nd]. Contract EY-76-S-02-2677. 32p. Dep. NTIS, PC A03/MF A01.

The velocity of water jet flow can be increased when the jet impacts a target material or another water jet. A theory describing such augmentation in terms of velocity, mass, and energy change is considered. The phenomena is sensitive to jet structure and the jet velocity profile. Jet velocity profiles do not remain constant over great distances from the nozzle, and ultimately disrupt into droplets. Within the droplet the profile is more regular and the velocity constant. The theory is extended to cover this case and experimental evidence of jet augmentation and its effects is presented.

37193 Geothermal energy well casing seal and method of installation. Matthews, H.B. (to Sperry Rand Corp.). US Patent 4,050,517. 27 Sep 1977. Filed date 14 Oct 1976. 10p.

A geothermal energy transfer and utilization system makes use of thermal energy stored in hot solute-bearing well water to generate a thermal working fluid from an injected flow of clean fluid. The working fluid is then used for operating a turbine-driven pump near the well bottom for pumping the hot solute-bearing water in liquid state to the earth's surface, where it is used by transfer of its heat content to a closed-loop generator-turbine alternator combination for the beneficial generation of electrical power. The deep well pump system is supported within the well casing pipe from the earth's surface by a turbine exhaust conduit. In view of the effects of differential expansion on the relative lengths of the well casing pipe and the exhaust conduit, a novel flexible seal is provided between the suspended turbine-pump system and the well casing. Furthermore, an arrangement is provided for protecting elements of the flexible seal during initial lowering of the deep well pump and its associated seal system into the well and then for automatically deploying the seals in their operating condition at the well bottom.

CORROSION, SCALING, AND MATERIALS DEVELOPMENT

37194 (UCRL—52000-77-7, pp 10-19) **Taming geothermal brines for electrical power.** Jul 1977.

In Energy and technology review.

In parallel with engineering development of the total-flow process, brine acidification is being investgated as a means for controlling scale and solids precipitation. Studies are being conducted to select the component materials best suited for handling acidified brine. Various methods being investigated for disposal of the spent brines are summarized. (JGB)

37195 Solids control for high salinity geothermal brines. Hill, J.H.; Otto, C.H. Jr.; Morris, C.J. (Univ. of California, Livermore). *Geotherm. Resour. Counc., Trans.;* **1**: 139-140(May 1977).

Solids which precipitate when high salinity geothermal brines are cooled can cause extensive erosion and plugging to occur in power plant components. During reinjection of spent brine, they may also cause plugging of the formation adjacent to the reinjection wells. Work done to characterize these solids and control their production by acidifying the brine to a pH <4.5 is described. At this time, control by acidification seems to offer an attractive alternative to conventional methods (filtering, settling, etc.) for removing suspended solids from spent brine prior to reinjection.

GEOTHERMAL RESERVOIR AND WELL PERFORMANCE

REFER ALSO TO CITATION(S) 37152, 37153, 37173

37196 (CONF-770440—, pp 77-88) **Hawaii Geothermal Project.** Kihara, D.H.; Chen, B.H.; Takahashi, P.K.; Yuen, P.C. (Univ. of Hawaii, Honolulu). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

Two potential reservoirs on the island of Hawaii were identified by preliminary geophysical surveys. One of these, a location in the Puna district near the eastern rift of Kilauea Volcano, was selected for an experimental well. Results of the analysis of ten-foot core samples and cuttings are given. Flow test results are summarized; temperature and pressure profiles are tabulated. The deposition of silica is a substantial problem. (JGB)

37197 (RLO—2429-3) **Evaluation and design of downhole heat exchangers for direct application.** Culver, G.G.; Reistad, G.M. (Oregon Inst. of Tech., Klamath Falls (USA); Oregon State Univ., Corvallis (USA)). Jul 1977. Contract EY-76-S-06-2429. 125p. Dep. NTIS, PC A06/MF A01.

Progress in an experimental and analytical research program to evaluate and improve the design of downhole heat exchangers (DHEs) for direct applications of geothermal energy is reported. Significant progress has been achieved in characterizing flows in wells and without perforated casings and DHEs installed, determination of energy extraction rates for conventional DHEs in both cased and uncased wells, and utilization of information obtained to develop and substantiate models of heat transfer within the well. Flow characterization was obtained by experimentally measuring temperature and velocity profiles. In uncased wells, there was a relatively large vertical temperature gradient (approximately 0.5°C/m) and

insignificant measured vertical flow, while for the same wells when cased the temperature gradient was essentially zero (approximately 0.03°C/m) and a large vertically upward flow was measured (9 to 14 cm/s as measured with a hot-film anemometer). These show that a significant connection cell is established after installation of the casing. The energy extraction rates for a conventional DHE both before and after casing of a 60 m deep well was experimentally measured. In the uncased well up to 300 kW was obtained while the cased well produced over 500 kW. Analytical heat transfer models were developed for the cased well both with and without DHEs. For the cased well without a DHE, the model predicts flow rates that agree with the measured value within about 30 percent. Further, the energy extraction rates predicted by the models agree even better with the measured values. These models allow the energy extraction rates of design parameter variations to be evaluated. At this stage, only trends can be shown but with additional substantiation they should produce optimum energy extraction designs.

RESERVOIR STIMULATION AND EXTRACTION TECHNOLOGY

REFER ALSO TO CITATION(S) 38322

37198 (CONF-770440—, pp 54-59) **Results of fluid-circulation experiments: LASL hot dry rock geothermal project.** Smith, M.C. (Los Alamos Scientific Lab., NM). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

The first large-scale field experiment to investigate the extraction of heat from hot dry rock is now in progress on the Jemez Plateau in northern New Mexico. The experimental system consists of two holes about 3 km deep, from each of which hydraulic fractures have been made. The two major fractures appear to be approximately vertical and parallel, and separated by about 9 m of granodiorite through which fluid is transmitted probably along a distributed set of secondary fractures. Experiments to this point have demonstrated that the surface area of each hydraulic fracture is sufficient to accomplish effective heat transfer from the rock, at about 200°C, to water circulated through the system; that there is no significant short-circuiting of the water within the fractures; but that the impedance to fluid flow through the rock between the fractures is too high to permit the rate of heat extraction (initially about 10 MWt) desired of the experimental system. An attempt to reduce impedance by leaching with dilute sodium carbonate solution was unsuccessful. Therefore an attempt is now being made to reduce it by re-drilling from near the bottom of one hole in order to produce a simple system geometry in which the two holes are connected directly through a single hydraulic fracture.

37199 **Geothermal brine production.** Berg, C.H. US Patent 4,059,156. 22 Nov 1977. Filed date 29 Apr 1976. 6p.

A method is described for the production of geothermal brines that avoids depressuring the brine below its flash point in the well bore and thereby avoids the scaling and plugging unavoidably experienced whenever high salt content brines are depressured, releasing carbon dioxide and upsetting their solubility equilibrium and precipitating calcium carbonate. The invention avoids the flashing of the geothermal brine by injecting a lift fluid immiscible with and of substantially lesser density than the brine into the production tubing to form a column of a mixture of brine and lift fluid which has a sufficiently lesser density than the column of brine that the hydrostatic head of the column of brine raises the mixture to the surface from where it is withdrawn without flashing, separating the lift fluid and processing the brine for heat recovery. Where the brine is extremely hot, the pressure is maintained at higher levels to avoid flashing by an additional column of brine below the production level. This is provided by establishing a column of the geothermal brine a substantial depth below its production interval, installing a production tubing for a substantial depth in the column of brine and injecting a lift fluid which yields a higher pressure at the top of the well.

DIRECT ENERGY UTILIZATION

REFER ALSO TO CITATION(S) 37152, 37169, 38304

37200 (CONF-7504139—, pp 187-200) **Geology and energy utilization of the Klamath Falls Known Geothermal Resource Area.** Lund, J.W. (Oregon Inst. of Tech., Klamath Falls). 1975.

From 13. engineering geology and soils engineering symposium; Moscow, ID, USA (2 Apr 1975).

In Engineering geology and soils engineering symposium.

Klamath Falls, Oregon, is located on a geothermal hot springs area which has been used by residents, principally in the form of hot water for space heating, at least since the turn of the century. Approximately 400 shallow-depth wells ranging from 90 to 1900 feet in depth are used to heat approximately 500 structures. This utilization includes the heating of residences, schools, a college campus, businesses (including a creamery, for milk pasteurization), heating swimming pools and melting snow from pavements. It is felt that only a small portion of the area's potential is being utilized, with speculation that a high temperature stream area exists below the known shallow reservoir. Well water, which ranges from 100 to 230°F, has been used directly in heating and drinking water systems; however, present practice is to use down-hole, hair-pin, heat exchanger (locally termed a coil) with city water as the circulating fluid. Even though at present only about one quarter of the city uses this geothermal resource, investigations are being made into district heating and the heating of large apartment units from a single well.

37201 **Aluminum flocks yield in mineral waters heated by geothermal steam. II. Neutralization of acid sulfate water.** Hirano, T.; Oki, Y.; Awaya, T.; Suzuki, T. (Hot Spring Research Inst., Kanagawa, Japan). *Bull. Hot Spring Res. Inst., Kanagawa Prefect.;* **5**: No. 2, 59-66(1974). (In Japanese).

Acid sulfate water, issuing from the swamp Ajigaike, is heated by geothermal steam and used for bathing. As the water dissolves aluminium at about 20 ppM, aluminium flocks appear during neutralization, resulting in a serious problem in transparency of the bath water. Neutralization of the water is required for use of the heated water. Several methods of neutralization are chemically and economically examined; these include use of limestone, slightly alkaline thermal water, etc. A neutralization plant using limestone combined with a filtration system using quartz sand is preferable for its economical maintenance.

GEOTHERMAL DATA AND THEORY

37202 **Regional variation of heat flow, geotherms, and lithospheric thickness.** Pollack, H.N.; Chapman, D.S. (Univ. of Michigan, Ann Arbor). *Tectonophysics;* **38**: No. 3/4, 279-296(23 Mar 1977).

From Symposium on heat flow and geodynamic processes; Grenoble, France (Aug 1975).

Geotherm families in which surface heat flow is the principal independent variable were constructed for continental and oceanic lithospheres. The continental model is characterized by geotherms in which surface heat flow is in equilibrium with heat flowing into the lithosphere at its base plus heat generated by radioactive decay within the lithosphere. The model accommodates the regional variation of the surface heat flow with proportional variations in the radioactivity of the surficial enriched zone and in the deeper heat flow. The proportionality is dictated by a new and general linear relationship between reduced heat flow and mean heat flow for a region (q^* congruent to 0.6 anti q_0), which enables both q^* and the mean heat production of the enriched zone to be estimated from knowledge of the mean surface heat flow of a province. The oceanic model is characterized by the transient cooling of a semi-infinite medium with an initial temperature gradient and some near-surface radiogenic heat production. The model yields a heat flow in satisfactory agreement with observations in the oldest ocean basins. The depth at which both the oceanic and continental geotherms reach approximately 0.85 of the melting temperature is shown to be a consistent estimator of the depth to the top of the low-velocity channel, or the thickness of the high-velocity lid overlying the channel. The lid was identified as being synonymous with the lithosphere, and a global map of lithospheric thickness based on the regional variation of surface heat flow was produced. The lithosphere is less than 100 km thick over most of the globe, but thickens appreciably and becomes more viscous beneath the Precambrian shields and platforms, regions of low heat flow. These characteristics of shields are consistent with recently reported models of the driving mechanisms of the plate system, which require greater retarding forces beneath plates with large continental areas.

37203 **Structure of the lithosphere beneath the Eastern rift, East Africa, deduced from gravity studies.** Fairhead, J.D. (Univ. of Leeds, Eng.). *Tectonophysics;* **30**: No. 3/4, 269-298(Feb 1976).

A compilation of all published and unpublished gravity data for the Eastern rift between latitudes 1°N and 5°S is presented. The Bouguer anomaly map reveals that the shape of the negative regional anomaly associated with the rift is approximately two-dimensional, striking east of north, of width 350 +- 50 km and amplitude 500 +- 100 g.u. relative to the background value of -1300 +- 100 g.u. to the west. The regional anomaly is interpreted in terms of an upward thinning of the lithosphere and replacement by low-density asthenosphere. This model is different from previous interpretations in that major lithospheric thinning is restricted to the region of the Eastern rift affected by the domal uplift and does not extend beneath the Lake Victoria region to the west. The gravity and seismic

models are compatible if the anomalous upper mantle (asthenospheric part), beneath the rift, is in a state of partial melt. A consequence of the revised regional anomaly is that it reduces previous amplitude estimates of the axial positive residual anomaly within the rift by at least 50 percent and generates negative anomalies over the rift shoulders in areas covered by Cenozoic volcanics. These negative anomalies are considered to be caused by the low density of the surface volcanics. Within the rift, elongated negative anomalies of amplitude 100 to 350 g.u. are associated with sedimentary basins and are attributed to low-density sediments up to 3 km thick. The positive residual anomaly along the axis of the rift can be interpreted in terms of either a dyke injection zone less than 15 km wide or by a dense infill body about 2.5 km thick. The positive anomaly is shown to be confined to the volcanic province of the Eastern rift and has its southern termination in the Magadi—Natron area, just north of where the Kenya rift valley changes to block faulting in N. Tanzania. This termination coincides with a change in the spatial distribution of the seismic and geothermal activity.

PROPERTIES OF AQUEOUS SOLUTIONS

37204 Ionic diffusion in naturally-occurring aqueous solutions: use of activity coefficients in transition-state models. Anderson, D.E.; Graf, D.L. (Univ. of Illinois, Urbana). *Geochim. Cosmochim. Acta;* **42**: No. 3, 251-261(Mar 1978).

The model of Lane and Kirkaldy (Can. J. Chem. 43, 1812 to 1828, 1965; 44, 477 to 485, 1966) for estimating diffusion coefficients in aqueous electrolyte solutions from limiting ionic conductances is rederived for a system of n salts with a common anion, by utilizing the equations of Miller (J. Chem. Phys. 71: 616 to 632, 1967b- 71: 3588 to 3592, 1967c). Salt and water activities are used, and it is of necessity assumed that the diffusion mechanism does not change with concentration. The revised model predicts the on-diagonal D/ sup v//sub ik/ of a 3 M solution in NaCl—KCl—H_2O to within 5 percent, compared with errors of 20 to 30 percent for the original model. Errors remain constant or decrease as concentrations increase to 3 M, so that predictions of these D/sup v//sub ik/ at even higher concentrations appear promising. Relatively large errors persist in our estimates of the small, off-diagonal coefficients in this system. Measured diffusion coefficients in $MgCl_2$—NaCl—H_2O extend over only a limited concentration range and are of only moderate accuracy. Nevertheless, the revised model predicts D_{11}/ sup v/, D_{22}/sup v/, and D_{21}/sup v/, the larger of the off-diagonal coefficients, with errors of only 5 to 20 percent.

PROPERTIES OF MINERALS AND ROCKS

REFER ALSO TO CITATION(S) 37516, 37782, 38323

37205 (CONF-770440—, pp 541-550) **Effect of temperature and stress on the absolute permeability of sandstones and limestones.** Aruna, M.; Arihara, N.; Ramey, H.J. Jr. (Stanford Univ., CA). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

Experiments by Weinbrandt (1972) indicated that the absolute permeability to water for consolidated sandstones decreased markedly with an increase in either confining pressure or the system temperature. Recent experiments by Casse (1974) showed that a large decrease in absolute permeability with temperature increase was peculiar to flow of water in the several consolidated sandstones studied. These experiments were repeated in the present study for other sandstones, and no strong effect was observed for flow of gas, mineral oil, or octanol. Under the hypothesis that a temperature level effect was caused by an attraction between water and quartz which increased with temperature increase, experiments were conducted with flow of water in both consolidated and unconsolidated sandstones. A large, reversible reduction in absolute permeability to water with temperature increase was observed, while no temperature level effect was observed for flow of gas or other non-aqueous fluids. Several experiments with flow of water through limestone samples were conducted. No temperature level effect was observed. It appears that temperature level may affect permeability to water in sandstone systems to an important degree. This should have important connotations to thermal oil recovery and geothermal fluid production.

37206 Koon ganseki no reikyaku ni yoru bisho hakai ni tsuite. (Microfracture by cooling of hot dry rocks). Kobayashi, H.; Matsumoto, R.; Hayamizu, H. Tokyo; Mining and Metallurgical Institute of Japan (1977). 2p. (CONF-770460—2). TIC.

From Spring meeting of the Mining and Metallurgical Institute of Japan; Tokyo, Japan (Apr 1977).

In order to utilize hot dry rock resources in which there is no natural hydrothermal system, it is necessary to develop effective methods for fracturing the strata in the neighborhood of the borehole. The growth of microcracks resulting from thermal hysteresis was studied in a model system using photomicrography. The rock specimens tested included Kofu and Emochi andesites and Inada granite. The samples were heated at a rate of 3°C/min and rapidly cooled by water. They were dried in a desiccator and subjected to tests of elastic wave propagation velocity, compressive strength, and tensile strength. The Inada granite showed a marked decrease in strength after heating, as did the Kofu andesite. The Emochi andesite demonstrated an increase in strength after heating. The growth in grain boundary cracks was inversely proportional to the temperature/strength characteristics.

37207 Experimental study of the stability of the association rhombic pyroxene + magnetite + quartz under hydrothermal conditions. Fonarev, V.I.; Korolkov, G.Ya.; Dokina, T.N. (Inst. of Experimental Mineralogy, Chernogolovka, USSR). *Geokhimiya;* No. 10, 1498-1511(1976). (In Russian).

Under hydrothermal conditions the stability field of the association pyroxene (Pr) + magnetite (Mg) + quartz (Qu) was determined by experiment at water pressures of 1000 and 5000 kg/cm², temperature range of 700 to 850°C and oxygen volatility (f/sub O_2/) corresponding to the nickel-bunsenite buffer (NNO). The experiments were carried out by the method of mineral association using synthesized minerals. The composition of rhombic pyroxenes was determined by the x-ray method according to the curve of ferruginity (F mole percent)—position of the reflex (610): d/sub (610)/ = $2.8748 + 2.3 \times 10^{-4} F + 1.2 \times 10^{-6} F^2$. The attainment of equilibrium was determined by the study of the kinetics of the Pr composition change at various temperatures. On the basis of experimental data the positive deviation from ideality of solid solutions of the enstatite-ferrosilite series at T = 800°C was determined, extrapolation of the boundaries of the association Pr + Mg + Qu stability field was carried out in a wide temperature range of P and f/sub O_2/ , the position of the monovariant equilibrium of the reaction $3FeSiO_3 + 0.5O_2 = Fe_3O_4 + 3SiO_2$ in T = P = lg f/sub O_2/ coordinates was determined; the values of the isobaric-isothermal potential of ferrosilite were found.

ROCK-WATER-GAS INTERACTIONS

REFER ALSO TO CITATION(S) 37171, 38332

37208 (CONF-770440—, pp 246-249) **Kinetics of reactions in geothermal fluids.** Downs, W.F.; Rimstidt, J.D.; Solomon, G.C.; Barnes, H.L. (Pennsylvania State Univ., University Park). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

In order to evaluate the kinetics of hydrothermal alteration reactions, a series of medium temperature (350°C), medium pressure (300 bar) systems to circulate hydrothermal fluids through rock samples was constructed. Two rock types, granite gneiss and biotite adamellite, were reacted at a series of temperatures with both air-saturated, distilled water, and 0.1 m sodium chloride brine. A series of experiments was also run using pure quartz sand and distilled water. By combining the quartz data with that obtained from the more complex rock-leaching experiments, the dominant rate-controlling reactions can be determined. Sodium chloride, in solution, not only enhances the rate and extent of oxygen isotopic exchange but also changes the dominant feldspar-fluid reaction from the incongruent dissolution of feldspar. Proton-alkali ion exchange appears to be unimportant, but first order rates are found for SiO_2 dissolution, for Na-K exchange and for Ca dissolution/exchange from plagioclase. A comparison of the predicted and observed rates of increase of silica in solution indicates that less than 10 percent comes from the dissolution of quartz. The granitic gneiss, La-6, consists of two feldspars, (plagioclase-An_{10}; alkali feldspar-K^+_{90}), quartz, and less than 5 percent mafic minerals-chlorite, epidote and sulfides. Rock type LA-11, biotite adamellite, also contains two feldspars (plagioclase-An_{30}; alkali feldspar-K^+_{95}), quartz but approximately 17 percent mafic minerals—biotite, 12 percent; hornblende, epidote, sphene and sulfides, 5 percent. Preliminary calculations indicate that the alteration of biotite to vermiculite is a rate controlling reaction for the addition of K^+ to water-dominant hydrothermal solutions. Alkali ion exchange between solution and feldspar at least partially buffers the solution composition when brines are involved.

37209 Effect of fluid pressure on oxygen isotope exchange between feldspar and water. Yund, R.A.; Anderson, T.F. (Brown Univ., Providence). *Geochim. Cosmochim. Acta;* **42**: No. 3, 235-239(Mar 1978).

The rate of oxygen isotope exchange between adularia and 2 M KCl solution was measured at 650°C at pressures from 125 to 4000 bar. Isotropic diffusion coefficients calculated from these data show a positive dependence on the fluid pressure. This dependence is opposite to the predicted effect of hydrostatic pressure and is attributed to the activity of "water" (H_2O, H^+ or OH^-) in the feldspar.

37210 Water and magmas: application of the Gibbs—Duhem equation. Dye, J.L.; Vogel, T.A. (Michigan State Univ., East Lansing). *Geochim. Cosmochim. Acta;* **42**: No. 3, 275-276(Mar 1978).

Burnham (1975a, b) has shown that in several alumino-silicate systems Henry's law constant is independent of silicate melt composition up to X/sup melt//sub H_2O/ = 0.5. He has used this fact to conclude that such silicate melts behave ideally over a wide range of compositions based on the application of the Gibbs-Duhem relation. Unless Henry's law is valid up to X/sup melt//sub H_2O/ = 1.0, the application of the Gibbs—Duhem relation to three component systems only shows that if one component obeys Henry's law, the other two components follow the two component Gibbs—Duhem equation. There is no thermodynamic requirement of ideality.

37211 Water and magmas: application of the Gibbs—Duhem equation; a response. Burnham, C.W.; Darken, L.S.; Lasaga, A.C. (Pennsylvania State Univ., University Park). *Geochim. Cosmochim. Acta;* **42**: No. 3, 277-280(Mar 1978).

A rebuttal is presented to the assertions of Dye and Vogel that the conclusion by Burnham (1975a, b) regarding Raoultian ("ideal") mixing behavior of the aluminosilicate components in a wide range of melt compositions is valid. It is emphasized that the mixing behavior of one component in a three-component system imposes constraints on the mixing behavior of the other two components, even when the form of the Gibbs—Duhem equation reduces to that for a two-component system. Indeed, the key element in Burnham's conclusion of ideal behavior for the aluminosilicate components in igneous-rock melts is the powerful constraint imposed by the fact that the activity of H_2O (a/sub H_2O/), hence its partial molal Gibbs free energy (anti G/sub H_2O/), is a function only of its mole fraction (X/sub H_2O/) at a given temperature and pressure (Burnham, 1975b, eqs. 3 and 4). Thus, the objective here is to show, with reference to the generalized ternary system 1-2-3, how imposition of this constraint for component 3 leads to the conclusion that components 1 and 2 mix ideally. (JGB)

ISOTOPE AND TRACE ELEMENT STUDIES

REFER ALSO TO CITATION(S) 36841

37212 Pyroxene thermometry in simple and complex systems. Wells, P.R.A. (Univ. of Oxford). *Contrib. Mineral. Petrol.;* **62**: No. 2, 129-139(1977).

Simple mixing models were applied to ortho- and clinopyroxene solid solutions and a semi-empirical equation of state extracted from the available experimental data for the diopside-enstatite miscibility gap. This equation successfully reproduces the miscibility gap over a temperature range of 800°C to 1700°C and is apparently also applicable to aluminous pyroxenes in the system $CaSiO_3$—$MgSiO_3$—Al_2O_3. The effect of iron solubility in the pyroxenes was calibrated empirically using most of the available experimental data for multicomponent pyroxenes. This semiempirical model reproduces most of the experimental data within 70°C. Temperatures calculated for naturally equilibrated Mg-rich two-pyroxene assemblages deviate markedly from those estimated using the thermometer of Wood and Banno (1973). These discrepancies can be attributed to large inaccuracies in the thermometer of Wood and Banno (1973) for Mg-rich compositions.

TIDAL POWER

WAVE ENERGY CONVERTERS

37213 Wave driven generator. Hagen, G.E. (to Williams, Inc.). US Patent 4,077,213. 7 Mar 1978. Filed date 13 Feb 1976. 16p.

A plurality of different sized floats are connected into an array through nonlinear interfaces so their relative motions drive hydraulic pumping means. Floats in the array are sized to present a "black body" to the ocean waves incident upon the array. Fluid moved by the pumping means is used to drive an electric turbogenerator.

WIND ENERGY

AVAILABILITY (CLIMATOLOGY)

37214 Methods for estimating wind speed frequency distributions. Justus, C.G.; Hargraves, W.R.; Mikhail, A.; Graber, D. (School of Aerospace Engineering, Georgia Institute of Technology, Atlanta 30332). *J. Appl. Meteorol.;* **17**: No. 3, 350-385(Mar 1978).

The Weibull function is discussed for representation of the wind speed frequency distribution. Methods are presented for estimating the two Weibull parameters (scale factor c and shape factor k) from simple wind statistics. Comparison is made with a recently proposed method based on the "square-root-normal" distribution with mean wind speed and fastest mile data as input statistics. The Weibull distribution is shown to give smaller root-mean-squar errors than the squar-root-normal distribution when fitting actual distributions of observed wind speed. Another advantage of the Weibull distribution is the available methodology for projecting to another height the observed Weibull distribution parameters at anemometer height.

37215 Note on vertical extrapolation formulas for Weibull velocity distribution parameters. Doran, J.C.; Verholek, M.G. (Atmospheric Sciences Department, Battelle, Pacific Northwest Laboratories, Richland, Wash. 99352). *J. Appl. Meteorol.;* **17**: No. 3, 410-412(Mar 1978).

The adequacy of a vertical extrapolation scheme for Weibull wind speed distribution parameters proposed by Justus and Mikhail is examined. While useful for ensemble averages, the technique can lead to significant errors in individual cases.

ECONOMICS

37216 Implementation issues of wind energy. Coty, U.; Vaughn, L. (Lockheed-California Co., Burbank, CA). pp 97-105 of New options in energy technology. New York; American Institute of Aeronautics and Astronautics, Inc. (1977).

From Conference on new options in energy technology; San Francisco, CA, USA (2 Aug 1977).

See CONF-770824—.

The effect of initial production quantity on the selling price of a two-megawatt wind turbine generator is determined. To this is added the effect of loan interest rates, taxes, and other annual operating expenses. The cost of electrical energy generated is determined and compared to the cost of fuel for private utilities and to the cost of buying energy wholesale for public utilities. From this compensation, the initial production quantities of wind turbine generators is determined which would bring cost of wind energy down to a competitive level. The data presented also show the effect on initial production quantity required of introducing incentives such as guaranteed loans. The effect of annual average windspeed at the site is assessed in terms of initial production quantity required.

ENVIRONMENTAL ASPECTS

37217 (DOE/EDP—0007) **Environmental Development Plan (EDP). Wind energy conversion, 1977.** (Department of Energy, Washington, D.C. (USA)). Mar 1978. 37p. Dep. NTIS, PC A03/MF A01.

The Environmental Development Plan (EDP) for wind energy conversion identifies health, environmental, safety, social, and economic issues to be addressed as wind energy conversion technologies advance toward public utilization. It states the research needed to resolve these issues and provides a plan for the orderly development of required research. The EDP will support the overall wind energy technology development, as described in Division of Solar Energy planning documents, by ensuring that health, environmental, and safety problems are specified in such a way that mitigation and control of potential problems are achieved in a timely manner. In addition, the plan provides a concise reference to these issues for public interest groups outside the agency. The EDP will be reviewed and updated annually.

WIND ENERGY ENGINEERING

APPLICATIONS

37218 (SAN—1101-76-1) **Wind machines for the California Aqueduct. Volume I. Executive summary.** Lindley, C.A. (Aerospace Corp., El Segundo, Calif. (USA). Energy and Transportation Div.). Mar 1977. Contract EY-76-C-03-1101-005. 22p. Dep. NTIS, PC A02/MF A01.

The California Aqueduct is a 684-mile long water system including natural waterways and a 444-mile length of canal and tunnel, that delivers water from the mountains of Northern California to arid Southern California for agricultural, industrial and residential use. The objective of the study was to examine the applicability of wind energy conversion systems to meet a part of the pumping needs of the Aqueduct. It was hoped that the intermittent nature of

the wind resource would not be detrimental to the Aqueduct operations because of the inherent storage capacity of the lakes and reservoirs along the canal and the capacity of the canal itself. Furthermore, the location of the major pumping load is in the mountainous regions along the Aquduct path where the topography naturally leads to a potential wind enery resource. The study was limited to a conceptual evaluation of one wind energy conversion system application to a major part of the Aqueduct.

TURBINE DESIGN AND OPERATION

37219 (DOE/NASA/1004—77/7) **Brief summary of the attempts to develop large wind-electric generating systems in the U.S.** Savino, J.M. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). 1977. Contract EX-76-A-29-1004. 18p. Dep. NTIS, PC A02/MF A01.

Interest in developing large wind-electric generating systems in the United States was stimulated primarily by one man, Palmer C. Putnam. He was responsible for the construction of the largest wind-power system ever built—the 1250 kilowatt Smith-Putnam wind-electric plant. The existence of this system prompted the U.S. Federal Power Commission to investigate the potential of using the winds as a source energy. Also, in 1933 prior to Putnam's effort, there was an abortive attempt by J.D. Madaras to develop a wind system based on the Magnus effect. These three projects comprise the only serious efforts in America to develop large wind driven plants. In this paper the history of each project is briefly described. Also discussed are some of the reasons why wind energy was not seriously considered as a major source of energy for the U.S.

37220 (DOE/NASA/1004—77/9) **Preliminary results of the large experimental wind turbine phase of the National Wind Energy Program.** Thomas, R.L.; Sholes, J.E. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). 1975. Contract EX-76-A-29-1004. 15p. (CONF-751042—2; NASA-TM-X—71796). Dep. NTIS, PC A02/MF A01.

From Conference on frontiers of power technology; Stillwater, OK, USA (1 Oct 1975).

A major phase of the wind energy program is the development of reliable wind turbines for supplying cost-competitive electrical energy. The preliminary results of two projects in this phase of the program are discussed. First an experimental 100 kW wind turbine design and its status are reviewed. Also discussed are the results of two parallel design studies, for determining the configurations and power levels for wind turbines with minimum energy costs. These studies show wind energy costs of 7 to 1.5 cents/kWh for wind turbines produced in quantities of 100 to 1000 a year and located at sites having average winds of 12 to 18 mph.

37221 (DOE/NASA/1004—77/11) **Wind tunnel measurements of the tower shadow on models of the ERDA/NASA 100 kW wind turbine tower.** Savino, J.M.; Wagner, L.H. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). Nov 1976. Contract EX-76-A-29-1004. 37p. (NASA-TM-X—73548). Dep. NTIS, PC A03/MF A01.

Detailed wind speed profile measurements were made in the wake of a $1/25$ scale and a $1/48$ scale tower models to determine the magnitude of the speed reduction (the tower shadow). The $1/25$ scale tower modeled closely the actual wind turbine including the service stairway and the equipment elevator rails on one face. The $1/48$ scale model was made of all tubular members. Measurements were made on the $1/25$ scale model with and without the stairway and elevator rails, and on the $1/48$ all tube model without stairs and rails. The test results show that the stairs and rails were a major source of wind flow blockage. The all tubular $1/48$ scale tower was found to offer less resistance to the wind than the $1/25$ scale model that contained a large number of square sections. Shadow photos are included to show the extent of the blockage offered to the wind from various directions.

37222 (DOE/NASA/3132—78/1) **Employing statid excitation control and tie line reactance to stabilize wind turbine generators.** Hwang, H.H.; Mozeico, H.V.; Guo, T. (Hawaii Univ., Honolulu (USA)). Apr 1978. Contract EX-76-A-29-1004. 78p. (NASA-CR—135344). Dep. NTIS, PC A05/MF A01.

This study presents an analytical representation of a wind turbine generator which employs blade pitch angle feedback control. A mathematical model is formulated. With the functioning MOD-0 wind turbine serving as a practical case study, results of computer simulations of the model as applied to the problem of dynamic stability at rated load are presented. The effect of the tower shadow is included in the input to the system. Different configurations of the drive train, and optimal values of the tie line reactance are used in the simulations. Computer results reveal that a static excitation control system coupled with optimal values of the tie line reactance will effectively reduce oscillations of the power output, without the use of a slip clutch.

37223 **Device for extracting energy, fresh water, and pollution from moist air.** Ockert, C.E. US Patent 4,080,186. 21 Mar 1978. Filed date 7 Jan 1977. 6p.

A device is described which extracts useful energy and fresh water from moist air, with an associated removal of pollutant particles entrained in the extracted water. The device comprises an enclosure with a tall stack and an extended base which has means for the creation and utilization of a contained tornado which is powered by the energy release associated with the rapid condensation of water from the incoming moist air.

37224 **Wind motor.** McNeese, W.C. US Patent 4,080,100. 21 Mar 1978. Filed date 28 Sep 1976. 8p.

A wind motor is described which has a double set of rotor blades of special configuration mounted between a central hub and an outer rim. The front rotor has an extending shroud protruding well in front of the blades for capturing the prevailing wind. The center of the rotor is solid with the blades at the center being configured so as to be substantially at right angles to the wind flow and thus form a substantially solid area at the center of the rotor. The specially configured blades angle away from the center hub with a backward tilt of approximate 10^0. Also, the blades twist so that the portion attached to the rim or shroud of the device present an air foil effect with tip structure for the leading edge being approximately 45^0 from the axis while the trailing edge is similarly at approximately a 45^0 angle in the opposite plane. The second rotor structure has similarly configured blade structure with one embodiment of the device providing the second rotor on the same shaft as the first rotor, while another embodiment has the second rotor mounted on another tubular member from the shaft on which the first rotor is mounted and also provided for rotation counter in direction to the rotation of the first rotor.

37225 **Device for converting fluid flow into kinetic energy.** Antogini, E. US Patent 3,976,396. 24 Aug 1976. Priority date 7 Jan 1974, Canada. 8p.

The present invention relates to a device for converting fluid flow kinetic energy into rotational kinetic energy comprising a body mounted for vertical rotation about a longitudinal axis thereof, a plurality of horizontally spaced vertically extending vanes pivotably mounted on the body and rotatable between an open position in which the vane extends outwardly from the body and a closed position in which the vane lies with one surface thereof adjacent the surface of the body. The plurality of feather members are spacedly mounted longitudinally of each frame and extend outwardly and transversely of the surface opposite to the one surface of the vane. The feathers are dimensioned to abut the body when the vane is in the open position to provide stop means for each vane.

ELECTRIC POWER ENGINEERING

POWER PLANTS AND POWER GENERATION

REFER ALSO TO CITATION(S) 37582

37226 (DOE/ERA—0007) **Interim report on the performance of 400 megawatt and larger nuclear and coal-fired generating units: performance through 1975.** (Department of Energy, Washington, D.C. (USA)). Apr 1978. 136p. Dep. NTIS, PC A07/MF A01.

This preliminary report is issued to provide data to States and utilities on the performance of powerplants in a readily usable form. Powerplant performance data for 400 MW and larger coal and nuclear units through 1975 are presented on a State, individual utility and a national basis. The summary tables allow direct comparison of performance data among utilities and States. An in-depth study of this data will be released in mid-1978. The major, accessible repositories of powerplant performance data in the U.S. are the Edison Electric Institute, the U.S. Nuclear Regulatory Commission (NRC), and the DOE. Of the three, the EEI data base is the most extensive and is the primary source for this report. The individual unit data and the national scope of this data base allowed for analyses of the four industry-recognized performance indices. Additional DOE information permitted the data to be aggregated in four ways--national, State, by utilities, and by utilities within each State.

COOLING AND HEAT TRANSFER EQUIPMENT AND SYSTEMS

REFER ALSO TO CITATION(S) 37945

37227 **Dams that never end.** Hansen, K.D. (Portland Cement Association, Denver); Avera, J.K. Jr. *Int. Water Power Dam Constr.;* **30**: No. 3, 25-27(Mar 1978).

It is often necessary to construct a reservoir completely contained by a single, endless embankment. In such cases interior dykes also have to be built to direct flow around the reservoir, and to mobilize as much of the surface area as possible for cooling. The design and construction of three circumferential embankments in the USA, each of a different type of fill material, are discussed. At many proposed sites for electric power generating stations, cooling reservoirs prove to be the most feasible system for removing the excess heat through induced evaporation. When these plants are located in flat regions with little or no topographic relief, it is necessary to create all the storage above the existing level. This requirement results in dams in the form of circumferential embankments—dams that meet themselves. These embankments have been built from a variety of materials, including solid soil-cement, sand, and clay.

37228 (ORNL-tr—4484) **Design of combined cooling systems.** Ageev, G.S.; Korolev, I.I. 1977. Translated by S.D. Blalock, Jr. from pp 1-15 of "Teploelektroproyekt" Moscow, 1977. 13p. Dep. NTIS, PC A02/MF A01.

An analysis of the operational cooling systems at steam and nuclear power stations recently developed on the basis of dry cooling towers is presented. Taking as an example the existing Isfaghan steam power station, the cooling system with dry cooling towers and peak coolers is comprehensively described. The report gives specifications of the power generating station as well as the climatic conditions of the area where the station is located. The operating conditions of the combined cooling system are thoroughly considered. The report furnishes a comprehensive description of the structural part of the main equipment related to the cooling system condenser, peak cooler and other components.

37229 Development and operating experience of dry cooling tower system. Kokubo, R. (Takasago Machinery Works, Japan); Urabe, T.; Doi, M. *Tech. Rev., Mitsubishi Heavy Ind.;* **13**: No. 3, 192-202(Oct 1976).

The cooling tower is considered as one of the most effective systems for solving the cooling water problem in power stations and industrial plants. Particularly, the dry cooling tower is drawing keen attention for the following reasons: no cooling water consumption; no plume formation; and long life of cooling tower. For the last several years research has been undertaken on the Heller type dry cooling tower system adapted to the economic and environmental conditions of Japan in order to develop the optimum combination of turbine, condenser, piping system, and cooling tower. The first cooling tower of this kind was installed in the 60 MW power plant in the Takasago Works of Kanegafuchi Chemical Industry Co., Ltd. in September 1974. The system and the results of this developmental research, field tests, and over one year's operation of the first unit are outlined.

POWER CYCLES

REFER ALSO TO CITATION(S) 37559

37230 (DOE/EDP—0021) **Environmental Development Plan (EDP). Advanced Power Systems Program, FY 1977.** (Department of Energy, Washington, D.C. (USA)). Mar 1978. 80p. Dep. NTIS, PC A05/MF A01.

The environmental issues, impacts, requirements, and projects related to fossil fuel technologies associated with ERDA's Advanced Power Systems (APS) programs, i.e., open cycle gas turbine (OCGT), for combined cycle use, closed cycle gas turbine (CCGT), and alkali metal vapor turbine (AMVT) are discussed. ERDA's APS program for the development of high temperature turbines is a long-term program to improve the efficiency of conventional turbine designs, and at the same time to develop turbine systems which can use coal or coal-derived fuels. This Environmental Development Plan (EDP) identifies the environmental, health, and safety problems which may occur from APS development and commercialization. It recommends areas of environmental research. This EDP will be updated annually to take into account the progress of the technologies toward commercialization, the environmental work accomplished by ERDA and other agencies, and the resolution of outstanding environmental issues concerning the technologies.

37231 (FE—1806-31) **Development of high temperature turbine subsystem technology to a "technology readiness status": Phase II. Quarterly report.** Caruvana, A. (General Electric Co., Schenectady, N.Y. (USA). Gas Turbine Div.). Oct 1977. Contract EX-76-C-01-1806. 49p. Dep. NTIS, PC A03/MF A01.

Technology testing of full-size, stationary, hot gas path components including both performance and endurance tests in a simulated turbine environment is a major element of the HTTT Phase II program. The test stand facility and the test specimens design and fabrication are discussed herein. A critical element is the test stand combustor which is being designed similar to the final Test Readiness Vehicle (TRV) combustor design. Supporting tests designed to supply significant data relative to gas-side heat transfer coefficients, deposition and corrosion effects of low-Btu gas, chemical cleanup of low-Btu gas, and coolant channel heat transfer characteristics are included in the Phase II program. The Turbine Simulator facility provides a "system" test of long term (250 to 500 hours) operation on real low-Btu gas. An advanced fixed-bed gasifier will be coupled to a state-of-the-art chemical cleanup system. This will be followed by a test combustor and a simulated Stage 1 nozzle. Study layouts are in preparation for the TRV-5 based upon a scaled TRV-7 with 48 Stage 1 vanes. The Stage 1 airfoils are specified as composite structures to maintain the 1000°F surface temperatures at the 2600°F firing temperature. Significant methods must be developed to construct these composite components. The program details requisite to this development activity are being evaluated. These include copper alloy development, selection of a water-cooling tube alloy, methods of forming cladding skins, and the complex assembly techniques required.

37232 (FE—1806-37) **Development of a high temperature turbine subsystem technology to a "technology readiness status": Phase II. Progress report, December 1977.** Caruvana, A. (General Electric Co., Schenectady, N.Y. (USA). Gas Turbine Div.). 9 Jan 1978. Contract EX-76-C-01-1806. 46p. Dep. NTIS, PC A03/MF A01.

Initial analysis indicates that the laser velocimeter composed of a two color laser system with a seeded hot gas stream will provide two dimensional turbulence data in the hot gas path tests. A conceptual design for a monolithic airfoil was developed for use in the turbine simulator heat transfer tests. Working drawings of the flat plate test sections for the shock tunnel tests are in process. A program plan for the motorized rig tests was developed concentrating on four basic areas. Work on bucket platform cooling passages, the first of these four areas, was initiated. System design work is proceeding with the definition of the complete design point cycle, the preparation of a cycle schematic, the calculation of off-design and off-ambient operating conditions and the development of performance accounting. Two flange to flange cross-sectional configurations have been established. Trade offs are proceeding such as two versus three bearings, etc. All configurations utilize the same combustor. Overall combustor flow splits for the base load operation was established. Secondary air has been drastically reduced in this initial design. A jet penetration study has concluded that there is sufficient flow to penetrate the hot center core. Stress analysis of a non-film cooled liner panel was completed. Preliminary wheel and spacer sizing was accomplished. Two profiles are under study. Preliminary stress evaluations were completed. A study layout of the inlet duct and front bearing support was initiated. Preliminary bearing sizes indicate an aft loading. Seal diameters are being reviewed and resized to obtain a forward loading. MVY, moment, shear, and deflection calculations in support of critical speed analysis are included. Details of the nozzle, bucket, water distribution system, design, materials processing and technology support activities are discussed.

37233 (FE—1806-38) **Development of a high temperature turbine subsystem technology to a "technology readiness status": Phase II. Progress report, January 1978.** Caruvana, A. (General Electric Co., Schenectady, N.Y. (USA). Gas Turbine Div.). 10 Feb 1978. Contract EX-76-C-01-1806. 65p. Dep. NTIS, PC A04/MF A01.

Specifications were prepared for the electrical switchgear and cabling required to provide power to the water skid pump motors for the hot gas path development tests. Detailed design work began on the test section for the heat transfer tests in the turbine simulator. The design of this test section includes a window for laser measurements of gas velocities. Design of the flat plate model for the shock tunnel test is complete. Analysis of the GEGAS-D operation continued. Based on the results of this analysis, the design basis for the Benfield Pilot Gas Clean Up System (PGCUS) was returned to that previously used during Phase I. These specifications are summarized. A system trade off between a two and a three bearing machine is in progress. Both machines have a common total bearing span of 17.5 feet. Drawings of the two configurations are included. The combustor design efforts centered around identifying an acceptable combustor arrangement compatible with the TRV and the sequence in which the 127.5 Btu/scf design fuel has to be burned throughout the speed and load range. The fuel nozzle design and the liner cooling design are discussed. The flammability limits of the 127.5 Btu/scf design coal gas were estimated in three different ways in order to determine the 2.74 allowable turn down ratio capability of the gas turbine combustor. Rationale for the 18% of load transfer point from ignition fuel to low Btu gas, and the 57% of load transfer to all low Btu gas is discussed. The combined cycle sensitivity to excess water flow through the water cooled turbine buckets and to reduced water collection efficiency of the stationary shroud is discussed. Quantitative results are provided. Status of the materials and processing studies in support of component design and test are discussed at length.

37234 (FE—1806-39) **Development of a high temperature turbine subsystem technology to a "technology readiness status": Phase II. Progress report, February 1978.** Caruvana, A. (Federal Council for Science and Technology, Washington, D.C. (USA). Committee on Energy Research and Development Goals). 10 Mar 1978. Contract EX-76-C-01-1806. 61p. Dep. NTIS, PC A04/MF A01.

A review of the Phase I hot gas path development test stand facility design has been completed. Design data affecting planned facilities services is being accumulated. Initial definition of measurements required for the combustor development have been established. Design of the test section for the heat transfer tests in the turbine simulator is complete. Work on the pilot gas clean up system has begun. Test specimens for the rotating motorized rig heat transfer experiments on bucket platform and tip shroud cooling passages were designed. A requirement for a modulating valve to limit airflows on the compressor discharge air extraction line to the gasification plant was established. A decision has been made to design the turbine wheels to 65,000 psi, average tangential stress. A program is being planned to determine the acceptability of IN706 for such wheels. An overall systems summary was prepared which documents the functional requirements for water distribution and metering. A design for the head end of the combustor system has evolved. This design uses an asymmetric burner with three (3) mixing cups. The upper cup is recessed in a "sheltered" burning zone and contains nozzles for both distillate fuel and coal gas fuel. The two lower cups inject coal gas fuel/air mixture directly into the paneled liner area. The operating sequence for these nozzles is discussed. Characteristics of the three most likely fuels to be burned in the combustor during Phase II are disclosed. Detailed status of the design of turbine nozzles and buckets is contained. An update on the status of the plasma spray coatings investigations and listing of the alloys to be examined in the corrosion improvement task are included.

37235 (FE—2357-21) **CFCC development program. Monthly report for January 1978.** (General Electric Co., Schenectady, N.Y. (USA). Energy Systems Programs Dept.). Mar 1978. Contract EX-76-C-01-2357. 23p. Dep. NTIS, PC A02/MF A01.

Revised/improved designs have been identified in several specific areas of the reference plant and effort has been initiated to implement these revisions. Use has been made of the General Electric technique for generation planning to project PFB system utilization in the utility network as a function of time and plant performance. Further work in this area will establish plant duty cycle requirements. Effort on the combustor steam generator focused on evaluation of water wall vs. refractory lined containment vessels. Based upon the judgement of Foster Wheeler, the reference plant (i.e., near term commercial approach) will focus on water wall designs. Forty-eight hundred hours have been accumulated in the burner rig materials exposure to PFB simulating exhaust. Excellent corrosion resistance was exhibited by three of the CFCC developed claddings. Comparative evaluation of the results of the Australian erosion tests with the Morgantown data indicate a consistency of results between the two test series, providing an additional body of data for erosion performance. Fabrication and checkout is in process for the NYSERDA probes, the Aerodyne cyclone, the electrostatic probe and charger, the materials test section and clad airfoils.

37236 Westinghouse launch uprated combined-cycle package. Berman, P.A.; DiNenno, P.A. *Energy Int.;* **15**: No. 4, 31-33(Apr 1978).

Westinghouse has introduced a new Power at Combined Efficiencies (PACE) 320 combined-cycle system which incorporates the proven PACE 260 plant with new components that improve its capability and reliability and have a higher thermal efficiency. The equipment is designed to operate either for peaking power or base load. The new package can handle higher mass flows and higher air inlet temperatures. Design changes and specifications are reviewed with emphasis given to the improvements to the 320 model performance. Most of the changes were made on the basis of field experience with the 260 model. The 320 is prepackaged for low installation costs and is suitable for intermediate applications of 340 to 450 MW.

37237 Economy of power generation in a combined cycle with coal gasification. Ahner, D.J.; Sheldon, R.C.; Garrity, J.J.; Kasper, S. *Arch. Energiewirtsch.;* **30**: No. 11, 971-992(Nov 1976).

Report on the machinery and equipment, the performance in service, and the costs of a large-scale integrated combined-cycle gasification plant. Processes for the production of clean fuel, and the basis for construction are described.

COMPONENTS

REFER ALSO TO CITATION(S) 36733, 37231, 37234, 37818, 37879

37238 Frame 9 service shows performance betters design values. Jeffs, E. (ed.). *Energy Int.;* **15**: No. 4, 17-20(Apr 1978).

The prototype Frame 9 gas turbine developed by Alsthom Atlantique and General Electric has performed for six years within its guaranteed design values and at its rated output, although guaranteed temperatures at the turbine inlet and the exhaust outlet were not reached. Electricite de France has decided to run the unit as guaranteed on the basis of the performance tests and without further costly modification. The project's history and goals are outlined along with specific events and statistics. Cracking problems in the gas path transition piece between the combustion chamber outlet and the turbine guide vane inlet were the only major problems requiring design changes.

37239 Concorde engine comes down to earth. Williams, D. *Energy Int.;* **15**: No. 4, 21-23(Apr 1978).

Rolls Royce is planning to market a modification of the Olympus 593 Concorde engine as a high-capacity generating package suitable for either peak-load or base-load utility use. The gas-turbine engine has been recognized as a cost-effective way of increasing capacity and achieving system reliability. World growth in electricity demand will be a key factor in how fast gas turbine installations spread as a source of low capital available energy. The Olympus 593 power plant is a prime mover of 50 MW, which can possibly be doubled to the 100 MW class. The airplane engine was modified to increase compressor efficiency and to provide the turbine rotor blades with pressure cooling air. A few materials and structural changes were also made and a new accessories pack designed. Studies indicate that economic performance will be best with a simple steam cycle. Rolls Royce will offer the gas generators to manufacturers of original equipment and will also sell directly to operators.

37240 Brown Boveri builds Saudi Arabia's largest power station. *Energy Int.;* **15**: No. 4, 25-26(Apr 1978).

Brown Boveri, a Swiss company, will build Saudi Arabia's largest gas turbine power station. Riyadh 5 will be an 8-unit complex with a 560-MW base load and will burn Khurais crude oil. All eight units will be installed in a common machine hall. Plans for the power plant layout and operation are summarized. Construction is expected to be completed during a 29-month period. The Riyadh Electric Company, with seven other power stations, is a pioneer in the use of gas turbines.

37241 Clutches give new lease of life to gas-turbine generation. Simmons, C.R. *Energy Int.;* **15**: No. 4, 41-44(Apr 1978).

The addition of a gear-type clutch to gas turbine generating plants has been found to lower fuel costs and to increase plant efficiency by enabling the plant to operate at either partial or full-load as well as at synchronous condensing modes. The higher system efficiency allows a more effective return on capital for the investors. The clutch provides efficient non-slip power transmission in the power generation mode, while indefinite synchronous condensing operations can be performed when the clutch is disengaged. First introduced in the 1950s, the SSS clutch has had a number of successful applications which have led to repeat orders from the manufacturers. A new use has been established for a gas turbine air storage plant under construction in West Germany.

37242 Wide market prospect for mid-size steam turbines. Hohn, A.; Spechtenhauser, A. (Brown Boveri and Co. Ltd., Baden, Switzerland). *Energy Int.;* **14**: No. 8, 21-24, 28(Aug 1977).

Growth in demand for industrial power supply and development of utility systems outside of Europe and America has narrowed the difference between the requirements for medium sized steam turbosets to serve both sectors. Future requirements for economic energy supply and conservation may continue to sustain the market for these machines over a wide area of activity. Many thousands of steam turbines of differing types have found application where power and heat utilization are combined. The reasons for this trend are that, firstly, by placing the emphasis on the combined supply of electricity and heat, the overall plant efficiency is materially improved; secondly, provided they are big enough, and if there are no guaranteed power supplies, turbosets are often a necessity to ensure the uninterrupted operation of industrial processes. District heating power plants nowadays mainly specify machines rated up to about 100 MW. These plants supply district heating needs with a fraction of the fuel required for individually fired boilers.

WASTE HEAT UTILIZATION

37243 (COO—4211-1/2) **Preliminary feasibility study of a grid-connected Integrated Community Energy System at Clark University. Volume II. Report and appendices.** (Clark Univ., Worcester, Mass. (USA)). Aug 1977. Contract EC-77-C-02-4211. 247p. Dep. NTIS, PC A11/MF A01.

The information evaluated the results of a 4-month feasibility study of an Integrated Community Energy System (ICES) at Clark University, Worchester, Mass. The study concluded that a demonstration ICES installation would save money and fuel; there are no

university regulations restricting this installation; sites are available which would permit linking the ICES to the existing heat distribution system and the New England Electric System; and having this facility at the university would provide a full scale laboratory for persons experienced in monitoring and evaluating energy systems. Recommendations are made for funding and for equiment selection. (LCL)

37244 Efficiency of a combined electricity- and heat-producing installation. Doneddu, M. *Rev. Gen. Therm.;* **42**: No. 193, 27-38(Jan 1978). (In French).

Having demonstrated that the concept of energy efficiency is meaningless for a combined installation, a frequently used electrical efficiency method is used to define a heat efficiency (using the concept of substituted consumption) and to differentiate the respective domains of application of these two efficiencies, one energy output being considered as auxiliary and enhancing the other. It is shown that an infinite number of other expressions can exist for the performance of the installation, each corresponding to a particular distribution of gains from primary energy sources used respectively for electrical and heat supply, in comparison with the consumptions for separate installations (substituted consumptions). With the gains on consumptions assumed proportional to the corresponding substituted consumptions, a relationship is established between the efficiencies and the saving of primary energy. The notion of exergetic efficiency is also recalled. Two numerical examples are given to illustrate these notions: firstly combined production by gas turbine and heat recovery boiler; then by drawing off steam at the third condensing stage S3 in a 250 MW power station.

ECONOMICS

REFER ALSO TO CITATION(S) 37508

37245 ABD's role in Asia's power sector. Heron, A.T.; Desai, V.V. *Indian East. Eng.;* **119**: No. 6, 295-299(Jun 1977).

A discussion is given on the significant role which the Asian Development Bank plays in helping countries to gear up their power projects through the Bank's technical and financial resources. While loans are essentially provided for individual power sector projects, the Bank has viewed these projects in terms of their place and contribution in the program of orderly development of a country's power system. This has required a comprehensive study of the present and future system requirements in terms not only of demand—supply but also of technical and institutional aspects to be carried out for utilities receiving their first loan from an international financial agency (viz: Cambodia, Lao PDR, Fiji, Nepal).

FUELS

REFER ALSO TO CITATION(S) 36702

37246 (CONF-770136—, pp 6p, Section 6, Paper 4) **FEA coal conversion program: historical perspective and future outlook.** Craven, D.B. (Miller and Chevalier, Washington, DC). 1977.

From Coal production, use and financing conference; Washington, DC, USA (25 Jan 1977).

In Conference on coal production, use and financing.

The Energy Supply and Environmental Coordination Act of 1974 (ESECA) (P.L. 93-319, June 22, 1974) as amended by the Energy Policy and Conservation Act (EPCA) (P.L. 94-163, Dec. 22, 1975) provided a response to the Arab Oil Embargo in an effort to reduce dependence upon foreign oil supplies. Coal conversion provisions of ESECA will be an important tool in regaining this Nation's energy independence. Section 2 requires FEA to prohibit a powerplant and provides discretionary authority to prohibit a major fuel burning installation (MFBI) from burning oil or natural gas (Prohibition Order). Section 2 also grants discretionary authority to order new powerplants and MFBI's in their "early planning process" to be designed and constructed with the capability of burning coal as their primary fuel. Certain other details of the Act, limitations implementation procedures and requirements necessary for issuance of a Prohibition Order are described. Progress in carrying out the provisions of the act are described, including the reduction in oil requirements and the increase in coal requirements. (LTN)

37247 (CONF-770136—, pp 10p, Section 6, Paper 5) **FEA mandatory coal utilization program.** Herman, S.A. (Kirkland, Ellis and Rowe, Washington, DC). 1977.

From Coal production, use and financing conference; Washington, DC, USA (25 Jan 1977).

In Conference on coal production, use and financing.

The Federal Energy Administration's progress in carrying out its responsibilities under the Energy Supply and Environmental Coordination Act of 1974 is described with emphasis on procedures, requirements for orders, hearings, compliance date extension, coal allocation authority, etc. Legislative extension of authority beyond June 30, 1977 is expected. Limited exemption is provided for peak load facilities and if alternate fuel and transportation facilities are not available. The Coal Substitution Incentive Act of 1977 provides for low interest loans and loan guarantees for acquiring pollution control devices necessary in plants converted to coal. (LTN)

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 36665, 36672, 36740, 37230, 37555, 38250

NOXIOUS GAS AND PARTICULATE ABATEMENT AND CONTROL

REFER ALSO TO CITATION(S) 36669, 36671

37248 Apparatus for determining the smoke density of flue gases of gas and fuel oil. Cocola, R.; Borgacci, L.; Gambini, A. (to Snamprogetti S.p.A.). US Patent 4,079,622. 21 Mar 1978. Filed date 10 Sep 1976. 2p.

An apparatus is described for determining the smoke density of flue gas by providing substantially uniform smoke spots. The device includes a piston-actuated pump for withdrawing gas from a smokestack through a cooled probe so that cooled gas from the stack is drawn through filter paper and is then cooled further for the removal of condensate. The cooled, dried gas then flows from the system during the compression stroke of the piston of the suction pump through a by-pass provided with a one-way value. The invention described provides the uniformity required to facilitate optical comparison between the obtained spots in the described filter paper and standard reference spots.

37249 Process and apparatus for removing sulfur from stack gases in the form of elemental sulfur. Nadkarni, R.M. (to Combustion Equipment Associates, Inc.). US Patent 4,078,048. 7 Mar 1978. Filed date 16 Feb 1977. 12p.

A process and apparatus for removing sulfur dioxide from gases such as stack gases are described. The gases are scrubbed with an alkali metal compound in an aqueous solution to form alkali metal sulfite/sulfate salts which are then reacted with barium sulfide to precipitate barium sulfite/sulfate and form alkali metal sulfide/bisulfide in solution. The alkali metal sulfide/bisulfide is oxidized to form elemental sulfur and regenerated wash liquid; and the barium sulfite/sulfate is reduced by roasting to form the barium sulfide required. In a preferable embodiment, coal is used as both the reductant and fuel in the roasting of the barium sulfite/sulfate and the stack gases from the roasting are scrubbed along with the primary stack gases. As an optional step a portion of the alkali metal sulfite salts may be oxidized to sulfate prior to reaction with barium sulfide.

37250 Trial plant may solve SO_2 emission problems. Narraway, R. *Processing;* **24**: No. 2, 53, 55(Feb 1978).

A demonstration plant was opened on Sept. 15, 1977, at the Dean H. Mitchell coal-fired power station near Chicago, for removing SO_2 from the flue gases and converting it to high-purity sulfur. The plant objectives, construction, and performance are described. It uses the Wellman—Lord process. (DLC)

37251 Combustion of coal and oil in power-station boilers. Hart, A.B. (Central Electricity Generating Labs., Leatherhead, Eng.); Lawn, C.J. *CEGB Res.;* No. 5, 4-17(Aug 1977).

Research aimed at understanding the combustion processes of fossil fuels well enough to provide a firm basis for efficient plant operation and control is discussed. Much has been learned about the physical aspects from laboratory studies of the burning of single particles, and computer techniques are revealing how the numerous individual chemical reactions couple together under different boiler conditions to yield particular flue-gas constituents. Sulfur trioxide is of special interest, since it combines with water vapor to form sulfuric acid, with risk of plant corrosion or of objectionable chimney emissions. Coal-fired boilers produce substantial quantities of alkaline ash, which helps to "mop up" acid (as well as other moderately volatile combustion products) and this eases some of the problems of combustion control. The virtual absence of ash in oil-fired plant means that control requirements here are much more critical. Air-to-fuel ratios must be optimized against sulfur-trioxide production and reduced thermal efficiency on the one hand and incomplete combustion, with excessive smoke and solids emissions, on the other. Methods of achieving the optimization automatically are under active study.

37252 Electrostatic precipitators. Coudert, J. *Promoclim A;* **6**: No. 1, 12-25(Feb 1975). (In French).

Paper illustrates operating principle of electrostatic precipitators and discusses it in some detail, noting that their technology and application has developed ahead of basic theory; describes

in some detail factors affecting operating efficiency (granule size, dust electrical resistivity, chemical composition, particle concentration, gas composition, temperature, average speed of the gas in the electrical field, etc.); illustrates main types of precipitator in detail, describing technological influences on their efficiency.

37253 Recovery of sulfur from flue gases using a copper oxide absorbent. McCrea, D.H.; Forney, A.J.; Myers, J.G. (Bureau of Mines, Washington, DC). *J. Air Pollut. Control Assoc.;* **20**: No. 12, 819-824(Dec 1970).

The development of methods to remove SO_2 from stack gases is discussed. A dry, solid absorbent prepared by impregnating copper salts into a $^1/_{16}$-inch alumina catalyst support is described. A preliminary process design and economic evaluation for power plant utilization are included. Previous pilot-scale and economic studies of an SO_2 removal process using a mixed metal oxide, alkalized alumina, identified major disadvantages of the absorbent. They were rapid degradation of the solid, excessive consumption of reducing gas, and high temperature difference between absorption and regeneration steps. Absorption of SO_2 from flue gas occurs readily at 300°C or above and is most rapid when the support contains 4 to 6 wt percent copper. While thermal regeneration is ineffective, reductive regeneration can be accomplished using H_2 or CH_4. Use of CH_4 is preferred since both gas consumption and residual sulfur level are lower. Physical and chemical properties remain stable after many cycles of absorption and regeneration. If the process is designed to be incorporated in a typical power plant, SO_2 is removed at 300°C in a fluid bed, where the solids are contained for 1 hour. The absorbent is then heated, and regeneration is accomplished at 425°C with CH_4 in a gravitating-bed reactor. The SO_2 evolved during regeneration is converted to concentrated sulfuric acid. The cost before byproduct credit is 1.62 mills per kilowatt-hour of power produced. If the power plant is modified so that absorption can be carried out at 425°C, costs may be significantly reduced.

POWER TRANSMISSION AND DISTRIBUTION

REFER ALSO TO CITATION(S) 37096, 37487, 37490, 37560

37254 (CONF-7610101—5) **Power cables now and in the future.** Wanser, G. (Kabel- und Metallwerke Gutehoffnungshuette A.G., Hannover (Germany, F.R.)). 1976. 25p. Dep. NTIS (US Sales Only), PC A02/MF A01.

From 59. VDE general meeting; Muenchen, F.R. Germany (11 Oct 1976).

A survey is presented of the problems to be faced with the underground supply of electric power to large, urban areas and of the contributions that improvements in power cable technology will make to solving these problems. It is concluded that the increase in population densities and the rising demand for energy on the part of individual consumers bring up problems for electricity supply and thus have a direct influence on development trends in cable engineering. During the last few years the increasing capacities required in power transmission have led to the use of higher voltages and to the application of special methods of cooling for the oil-filled cable. When the technical and economic possibilities with present-day cable techniques have been exhausted, we must anticipate the introduction of new types of cable, i.e., gas-insulated cables and superconducting cables. The problems involved in power distribution are being solved successfully by resorting to larger conductor cross-sectional areas and by raising the voltage levels. The advantages of plastic cables are also being utilized on a wide scale. The requirement that there be freedom from partial discharges in plastic cables operating at medium and higher voltages is becoming increasingly more widely adopted as a new quality criterion in cable engineering. New materials from the polymer range are permitting the introduction of fittings which are easier to install and which reduce costs. Cable engineering has already, to a considerable extent, adapted itself to face future problems. Even so, there are still a large number of problems in cable engineering requiring research, development and operation.

37255 Decoupled stability studies. Kasturi, R. (Indian Inst. of Tech., Kharagpur). *Proc. Inst. Electr. Eng. (London);* **125**: No. 4, 293-297(Apr 1978).

A new algorithm has been developed for fast-transient-stability studies, by decoupling the machines from each other and suitably modifying the electrical output to take into account the effect of the rest of the system. Apart from speed, this gives additional information about the quality of stability of the system.

37256 Modification of power system models using network theory. Jegatheesan, R. (College of Engineering, Guindy, MA). *J. Inst. Eng. (India), Electr. Eng. Div.;* **57**: No. 5, 228-231(Apr 1977).

The characteristics of a network are described by network matrices. The bus admittance matrix and the bus impedance matrix are the two models that are widely used in power system studies. In different situations it is required to modify these models to effect the change of reference bus. The modification of power system models due to change of reference bus is analyzed using network theory. The special properties of the rake equivalent circuit were invoked in deriving the required equations that are used to find the modified bus admittance and bus impedance matrices due to change of reference bus.

AC SYSTEMS, EHV AND UHV

37257 (DOE/EIS—0011) **Final environmental statement. Authorized New Melones 230-kV electrical transmission line, Central Valley Project, California.** (Department of Energy, Sacramento, Calif. (USA). Western Area Power Administration). 21 Apr 1978. 218p. NTIS, PC E03/MF E03.

The final environmental statement for the proposed New Melones 230-kV Electrical Transmission Line, Central Valley Project, California is presented. This project entails construction of about 23 miles (37 km) of 230-kV electric transmission line from the New Melones Switchyard to the Pacific Gas and Electric Company (PG and E) Bellota-Herndon No. 2 line near Oakdale, California. The environmental impacts and adverse environment effects include: the transmission line and associated access roads will have a visual impact on a predominantly rural and recreational area; soils and vegetation will be disturbed during construction; vegetation will be removed or trimmed as necessary for construction and to provide electrical clearances for conductors; wildlife habitats may be temporarily disturbed during construction and operation due to noise; about 285 acres (115.4 ha) of land will be devoted to transmission line right-of-way and about 12 miles (19.3 km) of new access roads are required; and reliable "clean" power will be furnished to the service area. (LCL)

37258 Some nonlinear automatic operations in a large electric network. Pelletier, P.C. (Hydro-Quebec, Montreal, Can.). *Can. Electr. Eng. J.;* **2**: No. 3, 9-14(Jul 1977). (In French).

Due to the abrupt nature of the major disturbances that may endanger the security of an electrical network, it is but natural to conclude that some of the corrective actions should also be rapidly applied automatically for early completion, in a bulk, nonlinear fashion; the linear controls can then take over and use up the design margin of the system to optimize its subsequent security. These techniques are often almost equivalent to reducing the absolute contingency level of the disturbance by one, that is from the complete network, by using reliable and well coordinated automatic schemes, in place of some overdesign to be sacrificed at the first event. Among the many nonlinear automatic operations available to the designer, one finds generator dropping, load shedding, reactive elements switching, line switching, etc. An outline is given of the main aspects of three such schemes designed to meet some of Hydro-Quebec's particular system problems in order to improve its stability and security; these are: automatic removal of 735 kV line compensation inductors for stabilization purposes, automatic generator dropping system for the Churchill Falls generation and transmission network and, automatic load shedding system for the interconnected network.

DC SYSTEMS

37259 4kV-1,500A thyristor for high voltage dc transmission. Igarashi, Y.; Komiyama, T. *Toshiba Rev., Int. Ed.;* No. 112, 19-22(1977).

The design, fabrication, operating characteristics, and performance of the world's largest new silicon thyristor, the 4 kV-1500A, model No. SF1500GX21 are described. This thyristor will be used in an ac-dc converter for a Hokkaido—Honshu power link in Japan. (LCL)

SUPERCONDUCTING AND CRYOGENIC SYSTEMS

37260 Dielectric design considerations for a flexible superconducting power transmission cable. Forsyth, E.B.; McNerney, A.J.; Muller, A.C. (Brookhaven National Lab., Upton, NY). *Adv. Cryog. Eng.;* **22**: 296-305(1977).

The mechanical properties and electrical performance of 5 candidate materials, i.e., high density polyethylene, oriented polyethylene, polyamide, polysulfone, and polycarbonate, for dielectric insulation in flexible superconducting power cables were measured. Examination of the test results indicates that none simultaneously fulfills all the requirements of superconducting cable design; however, several have excellent properties and are close to meeting these requirements. Polyethylene easily meets the dielectric requirements but was found to possess substandard yield strengths and tensile moduli. Polyamide and polysulfone exhibited acceptable yield strengths but their moduli are probably still too low for satisfactory taping. Also, the dielectric properties of these materials may be

slightly outside design specifications. The polycarbonate was found to possess completely acceptable mechanical properties, but its loss tangent appears to be much too high. The preliminary results obtained with the 70 ft sample cable indicate that many practical problems still have to be overcome in the design of terminations, stress cones, and cable. There is some evidence that the armoring process caused pinching of the polyethylene insulation. For these reasons the somewhat lower corona inception levels measured in the large sample are explainable and better techniques should lead to substantially better performance.

37261 Design of helically-wound superconducting ac power transmission cables. Morgan, G.H.; Forsyth, E.B. (Brookhaven National Lab., Upton, NY). *Adv. Cryog. Eng.;* **22**: 434-443(1977).

The design of helically wound superconducting ac power cables and the electrical complications that arise from helical current paths are discussed. The simplest and most economical method of winding the conductor of a coaxial cable to achieve flexibility is with both inner and outer conductors in the form of single helices. Of the three conditions that must be satisfied it is probably most important to ensure that the outside of each cable encloses no axial flux. This compromise leaves flux in the central cooling channel of each cable. If both conductors consist of two helices having opposite but almost equal pitch of length πd, the resulting coaxial structure excludes field from the center, has zero net axial flux, and has zero shield voltage drop. Both pairs of windings have the same radial contraction and would match a helically wound dielectric having twice the contraction coefficient. There is no difference in induced voltage between layers of the core or shield, thus eliminating any need for insulation and transposition of the two layers of the core. The absence of insulation possibly improves radial heat transfer, an important consideration during faults, and should improve superconductor stability by providing an alternate current path around local defects. The double helix has a magnetic field between the layers, which increases the superconductor loss slightly compared to a single helix and makes it impossible to put much normal metal even on the low field side of the high-field superconductor. Hence, the normal metal needed for huge fault currents must be present in the form of added pairs of helices inside the inner conductor and outside the outer conductor. It is thought that with such protection, recovery from quenches while carrying normal load current will be possible.

NUCLEAR POWER PLANTS

REFER ALSO TO CITATION(S) 37226, 37228

37262 Nuclear reactor types and designs. III. Perina, F. pp 39-73 of Atomy slozi cloveku. Vyuziti jaderne energie v praxi. Prague, Czechoslovakia; Prace (1976). (In Czech)

A brief historic survey is presented of the development of nuclear reactors in the world and their classification is given with regard to different aspects. A detailed description is given of typical examples of reactor types, such as graphite moderated reactors, heavy water reactors, pressurized water reactors, fast breeder reactors, high temperature reactors, thermonuclear reactors, test reactors and magnetohydrodynamic generators. Special attention is devoted to the reactor of the first Czechoslovak nuclear power plant A-1.

37263 (KFK—2435, pp 492-495) **Development of methods and techniques for the decommissioning and ultimate disposal of nuclear facilities.** Apr 1977. (In German).

In Second semiannual report 1976.

Program for research consists of: 1. Dismounting, crushing - steel/concrete; conditioning of large components; auxiliary systems; 2. means of reactor component transportation from nuclear power station; 3. waste conditioning; 4. setup of time schedule for decommissioning; 5. special arrangement of reactor components; 6. new reactor lines. Work completed includes the investigations relating to 1 and 2 . Points 3 to 6 were treated but not completed during the period of reporting.

37264 (ORNL/NUREG/NSIC—141) **Summary data for U.S. commercial nuclear power plants in the United States.** Heddleson, F.A. (Oak Ridge National Lab., Tenn. (USA)). 20 Mar 1978. Contract W-7405-ENG-26. 92p. Dep. NTIS, PC A05/MF A01.

A compilation of data is presented for all United States commercial nuclear power plants for which a construction permit application was made through the Nuclear Regulatory Commission. The data are compiled in four separate tables with cross-referencing indexes: Table 1—General Data; Table 2—Reactor Data; Table 3—Site Data, and Table 4—Circulating-Water System Data. The power plants are listed in numerical order by docket number in all four tables.

37265 Desalination by very low-temperature nuclear heat. Saari, R. (Nord-Aqua, Helsinki). *Nucl. Technol.;* **38**: No. 2, 209-214(Apr 1978).

From Conference on low-temperature nuclear heat; Otaniemi, Finland (21 Aug 1977).

A new seawater desalination method, Nord-Aqua Vacuum Evaporation, which utilizes waste heat at a very low temperature, has been developed. The requisite vacuum is obtained by a barometric column and siphon, and the dissolved air is removed from the vacuum by water flows. According to test results from a pilot plant, the process is operable if the waste heat exists at a temperature 7°K higher than ambient. The pumping energy that is then required is 38 kJ/kg, or 1.5 percent of the heat of vaporization of water. Calculations reveal that the method is considerably superior economically to conventional distilling methods.

37266 World nuclear power plant data base of the French Atomic Energy Commission. Leralle, J.C. (Commissariat a l'Energie Atomique, Brussels); Martin, G.A. pp 184-200 of Generalized data management systems and scientific information. Paris; OECD Nuclear Energy Agency (1978).

From OECD/NEA working group on nuclear information; Berkeley, CA, USA (5 Oct 1977).

See CONF-771062—.

The expansion in the construction of nuclear plants for energy production has brought with it a need for data on the characteristics and performance of nuclear power plants to be used for planning and other studies by governments, public and private enterprises in the nuclear field, and financial institutions. The data base described is an implementation of a GDMS written in APL, and carries technical and economic data on nuclear power installations worldwide. 2 figures.

37267 Strategies for the future. Leach, G. (International Institute for Environment and Development). pp 56-79 of Nuclear power and the energy future. London; Symposium Press (1977).

From Forum on nuclear power and the energy future; London, UK (11 Oct 1977).

See CONF-7710122—.

Official forecasts of UK demand and supply are examined. Renewable sources of energy and methods of energy conservation are discussed in some detail. It is concluded that the introduction of known technologies could hold UK primary fuel consumption at its present level while allowing for substantial material growth. It is suggested that the expansion of nuclear power be delayed for a few years and that this period be used to develop the most socially, economically and environmentally attractive long range energy strategies.

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, BOILING WATER COOLED

REFER ALSO TO CITATION(S) 37352, 37362, 37363, 37406, 37432, 37433, 37437, 37439, 37440, 37442, 37444, 37447, 37448, 37449, 37450, 37451, 37455, 37459, 37474, 37476

37268 (BNL-NUREG—23021) **Corrosion of materials in spent fuel storage pools.** Weeks, J.R. (Brookhaven National Lab., Upton, N.Y. (USA)). Jul 1977. Contract EY-76-C-02-0016. 21p. Dep. NTIS, PC A02/MF A01.

The current delays in establishing a national fuel reprocessing center have required many of the LWR licensees to expand their fuel storage capabilities either by modification of existing pools or addition of new fuel storage pools. This report reviews the potential corrosion problems that might develop during the long-term (10 plus years) storage of nuclear fuels in these storage pools. Zircaloy-clad fuels with burnups up to 33,000 MWd/MTU have been successfully stored in fuel storage pools for periods up to 13 years in U.S. pools and 14 years (at lower burnups) in Canadian pools.

37269 Fouling in boiling water systems. Chapter 15. Macbeth, R.V. (UKAEA Reactor Group, Winfrith. Atomic Energy Establishment). pp 323-342 of Two-phase flow and heat transfer. Butterworth, D.; Hewitt, G.F. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment) (eds.). Oxford; University Press (1977).

Water boiling surfaces usually acquire deposits of one kind or another, often referred to as 'crud'. In steam power stations, where water quality is usually closely controlled, the crud tends to be mainly magnetite (Fe_3O_4) with other compounds present in varying amounts. The present chapter describes some of the detailed features of these crud deposits and examines the effect they may have on metal surface temperature, burnout, and pressure drop.

37270 (IKE—5-205) **Calculation of mass flow and steam quality distribution on fuel elements of light-water cooled boiling water nuclear reactors.** Hermanns, H.J. (Stuttgart Univ. (TH) (Germany, F.R.). Inst. fuer Kernenergetik und Energiesysteme). Apr 1977. 94p. (In German). Dep. NTIS (US Sales Only), PC A06/MF A01.

By the example of light-water cooled nuclear reactors, the state of the calculation methods at disposal for calculating mass flow and steam quality distribution (sub-channel analysis) is indicated. Particular regard was paid to the transport phenomena occurring in reactor fuel elements in the range of two phase flow. Experimentally determined values were compared with recalculations of these experiments with the sub-channel code COBRA; from the results of these comparing calculations, conclusions could be drawn on the suitability of this code for defined applications. Limits of reliability could be determined to some extent. Based on the experience gained and the study of individual physical model concepts, recognized as being important, a sub-channel model was drawn up and the corresponding numerical computer code (SIEWAS) worked out. Experiments made at GE could be reproduced with the code SIEWAS with sufficient accuracy.

37271 (JAERI-M—7092) **Release of fission products from a fuel rod with an artificial hole through cladding irradiated in an in-pile water loop.** Ishiwatari, N. (Japan Atomic Energy Research Inst., Tokyo). May 1977. 27p. (In Japanese). Dep. NTIS (US Sales Only), PC A03/MF A01.

Iodine spiking from a defective fuel rod into the primary coolant was measured, concerning main steam pipe breakage of a BWR plant. The fuel rod with an artificial pin hole was irradiated in the in-pile test section of water loop JMTR.OWL-1. Experimental conditions are depressurization and temperature drop of the primary loop coolant and diameter and position of the pin hole. The effect of coolant water flow through the pin hole on the fission products release was examined. The extrapolation of the results to BWR is made by way of the amount of fission products in free space of the fuel rod.

37272 (KFK—2435, pp 306-331) **Investigations of the influence of oxide fuel and fission products on the mechanical properties of zircaloy-cladding tubes under accident conditions.** Hofmann, P.; Politis, C.; Kurz, K.; Metzger, H.; Rejman, G.; Scheckel, B. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Material- und Festkoerperforschung). Apr 1977. (In German).

In Second semiannual report 1976.

Investigations continued of the influence exerted by the oxygen potential of oxide fuel on the strain and rupture behavior of short Zr-4 cladding tubes. The experiments were performed under argon. The pressure and temperature were measured continuously. The initial pressure differential varied between 1 and 60 bar at room temperature. Testing of methods of pressure measurement at temperatures of the diaphragm above 200°C (pressure measurements at high temperatures are necessary for studies relating to stress corrosion cracking of Zr-cladding tubes due to iodine). First UO_2/Zr-reaction experiments were carried out under PCM-conditions between 1,100 and 1,400°C in a high pressure autoclave system. Study of the chemical interactions between simulated fission products and Zr at temperature up to 1,200°C.

37273 (KFK—2435, pp 215-217) **Experimental data acquisition and processing of the dynamic behavior of the pressure vessel test internals under the HDR-blowdown-experiments.** Appelt, K.D.; Cramer, M.; Eberle, F.; Kadlec, J.; Lang, G.; Schnauder, H. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Reaktorentwicklung). Apr 1977. (In German).

In Second semiannual report 1976.

The autoklave was completed and accepted by the Technical Inspectorate (TUeV). The associated electromagnetic shaker has been delivered. Mounting has started on a vibration insultated concrete block built for this purpose. The test program for the examination of the prototype measurement transducers has been specified in detail and the necessary auxiliary test equipments were designed and are being fabricated. The laboratory basic tests so far performed on three prototype displacement transducers yielded very satisfactory results. Determinations included the dependency of zero, sensitivity and linearity on the temperature in a furnace at atmospheric pressure. In HDR the interferences were investigated using different types of measurement cable. The results were quite positive so that doubts were largely eliminated. A concept of instrumentation was elaborated for the measurements planned in addition on the thermal stratification in the HDR pressure vessel and the specifications were defined which are required for the invitation of tenders and placing the order for this measurement equipment. Work has been carried on to correct the dynamic measurement errors occuring during blowdown tests.

37274 (KFK—2435, pp 209-214) **Design and precalculation of the HDR-blowdown-experiments on dynamic loading, stresses and deformations of reactor vessel internals.** Krieg, R.; Schlechtendahl, E.G. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Reaktorentwicklung). Apr 1977. (In German).

In Second semiannual report 1976.

The stresses in the upper core barrel flange have been analysed in detail with STRUDL/DYNAL. Nonlinearity effects of the material properties were included. It was found that the blowdown load does not lift the flange and surface pressure is acceptable. The 0,2% strain value is exceeded only locally and insignificantly. The rigging diagram of the vessel has been established. The blowdown load on the core barrel has been computed with the two-dimensional code YAQUIR for reference test No. 3. Results of DAPSY calculations (performed by LRA) were used as input for the pressure in the nozzle and lower plenum. The predicted pressure signals at the locations of the pressure sensors have been documented.

37275 (KFKI—77-16) **HOTRAN-2. A code for coolant flow transient calculations of water-cooled reactor codes.** Perneczky, L.; Szabados, L.; Kovacs, L.M. (Kozponti Fizikai Kutato Intezet, Budapest (Hungary)). Feb 1977. 20p. Dep. NTIS (US Sales Only), PC A03/MF A01.

HOTRAN-2 is a digital computer program for predicting the thermal and hydraulic performance of an open-channel reactor core. The core, or a section of it, is divided into two parts: the first part is assumed to consist of a large number of normal channels, the other part, of a small number of hot channels. It is assumed that thermal and flow parameters are unaffected by cross-flow. The code was primarily designed for power and flow transients e.g. associated with a loss of coolant flow accident, but it has also been used for steady-state calculations. The code calculates single-phase and two-phase enthalpy, density, steam quality, temperature and mass flow rate of the light water coolant as functions of time and space coordinates.

37276 (KFKI—77-53) **Thermohydraulic calculation of reactor boiling channel.** Maroti, L. (Kozponti Fizikai Kutato Intezet, Budapest (Hungary)). Jul 1977. 145p. (In Hungarian). Dep. NTIS (US Sales Only), PC A08/MF A01.

The most widely used methods of thermohydraulic calculations are reviewed. Tube geometry is used as the model for the boiling channel. Only the calculation of steady state operating conditions is considered. The second part describes new methods developed by the author for the calculation of two-phase frictional pressure drop, boiling heat transfer coefficient, and steam quality in subcooled boiling. Finally a great number of measured data is compared with the results of these new calculations.

37277 (NUREG/CR—0003) **Small scale modeling of hydrodynamic forces in pressure suppression systems. Final report.** Anderson, W.G.; Huber, P.W.; Sonin, A.A. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Mechanical Engineering). Dec 1977. 72p. NTIS $5.25.

Experiments were conducted to test the validity of the scaling laws which have been put forward for the small-scale modeling of the air clearing phase of flow into the condensation pool of a pressure suppression system. Three geometrically similar wetwells (differing in linear dimension by a factor of 4) were used, along with two liquids (differing in density by a factor of three) and three gases (differing in enthalpy by a factor of ten). When using different pressures, liquids, and gases, the dimensionless pressures were in excellent agreement as long as the four scaling parameters were held constant. The enthalpy flux must be scaled by the use of an orifice to ensure that the pressures will scale.

37278 (NUREG/CR—0026) **Evaluating strength and ductility of irradiated Zircaloy: Task 5. Quarterly progress report, October—December 1977.** Bauer, A.A.; Gallagher, W.J.; Lowry, L.M.; Markworth, A.J. (Battelle Columbus Labs., Ohio (USA)). Jan 1978. 42p. (BMI—1992). NTIS $4.50.

Expanding-mandrel tests have been conducted to evaluate the influence of test temperature (204 to 482 C) and of strain rate at 371 C on the strength and ductility of spent-fuel cladding under simulated PCI conditions. The ultimate strength shows a continuous decrease with increase in test temperature. Uniform strain shows no effect of temperature with uniform and failure strains coinciding at temperature to 371 C. Above this temperature, failure strains increase as the failure stress decreases. Both ultimate strength and uniform strain decrease with increase in strain rate. The effect of transient- and isothermal-annealing on tube strength and ductility in expanding-mandrel tests also has been measured. Trends of decreasing strength and increasing ductility are noted as annealing proceeds. Indications of a ductility minima at intermediate stages of annealing have been obtained.

37279 (ORNL/NUREG/TM—181) **Creepdown of Zircaloy fuel cladding: initial tests.** Hobson, D.O. (Oak Ridge National Lab., Tenn. (USA)). Apr 1978. Contract W-7405-ENG-26. 41p. Dep. NTIS, PC A03/MF A01.

The report describes the initial creepdown tests of Zircaloy fuel cladding in which the surface displacements of the specimens have been measured as a function of time. Such measurements were made with a high accuracy, high precision eddy-current device capable of operation at elevated temperatures and pressures. Tests were conducted at 371°C (700°F) and external pressures of 14.5 to 17.2 MPa (2100 to 2500 psig) on specimens of reactor grade Zircaloy-4 fuel cladding in the unirradiated, stress relieved condition. Data are reported in several forms--as individual radial displacements of the cladding surface with time; as average diameter and ovality changes with time; in sequential photographs of analogue models; and with a preliminary discussion of mathematically modeled surfaces. It is concluded that the creepdown phenomenon, although complicated to test and describe, may not be as difficult to understand as previously thought. Further testing will refine present knowledge of cladding behavior relative to strain behavior under creep conditions.

37280 Reactivity behavior of a reactor core loaded with gadolinium-poisoned fuel assemblies. Termaat, K.P. (N.V. Kema, Arnhem, Netherlands). *Nucl. Technol.;* **38**: No. 3, 367-373(May 1978).

To obtain a longer power cycle length, the beginning-of-cycle excess reactivity of the reactor core must be increased. In the case of the Dodewaard reactor, this was done by raising the ^{235}U enrichment of the fuel from 2.5 to 2.8%. To meet the shutdown margin criterion, the burnable poison, gadolinium, was added to 2 out of 36 fuel pins of each fresh fuel assembly. When a large number of this type of fuel assembly is used to reload a reactor core, the reactivity behavior of the hot operating core, as well as the variation in shutdown margin of the cold core as a function of burnup must be known. By using a relatively simple analytical model, a reasonable prediction of these two phenomena could be made as shown by comparison with actual measurements and results of calculations with the FLARE computer code.

37281 Nuclear reactor with locking-key safety mechanism. Aubert, R. (to Commissariat a l'Energie Atomique). US Patent 4,077,840. 7 Mar 1978. Priority date 28 Oct 1975, France. 8p.

A device for coupling a pressure vessel closure cap to an upper structure for supporting the reactor internals comprises a plurality of locking-keys which are guided in translational motion within radially disposed housings and can be moved into outwardly projecting positions by externally-controlled actuating means in order to engage in opposite recesses formed in the internal wall of the closure cap.

37282 Matrix swelling rate of UO_2. Assmann, H.; Manzel, R. (Kraftwerk Union A.G., Erlangen (Germany, F.R.)). *J. Nucl. Mater.;* **68**: No. 3, 360-364(Nov 1977).

This paper describes the experimental determination of the UO_2 matrix swelling rate of a Light Water Reactor fuel (LWR) by postirradiation examinations. The authors define fuel swelling as the relative volume or density change of an initially pore-free matrix.

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, NON-BOILING WATER COOLED

REFER ALSO TO CITATION(S) 37268, 37272, 37278, 37279, 37362, 37365, 37409, 37432, 37437, 37457, 37458, 37459, 37460, 37461, 37467, 37471, 37476

37283 (IAE—2619) Calculation of neutron spectrum in the thermal range by means of differential models of thermalization. Sidorenko, V.D. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1976. 23p. (In Russian). Dep. NTIS (US Sales Only), PC A03/MF A01.

Procedure is considered for obtaining differential equations of neutron thermalization in a heterogeneous cell. Particular attention is given to formulating the equations for the cells of the core of an WWER type reactor.

37284 (KFK—2435, pp 183-187) Dynamic load of PWR pressure suppression systems. Mueller, R.A. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Reaktorentwicklung). Apr 1977. (In German).

In Second semiannual report 1976.

In the analytical studies on the dynamic behavior of the containment structure work concentrated on the outer spherical shell. It was found that the eigenfrequencies of this shell are very close to each other in the 60 Hz range and that the radial deflections are proportional to the pressure load in a first approximation. First attempts were made to take into account the influence of inertia of the water moved along with the structure. The parameter computations were continued which had been performed on behalf and for the account of TUeV Baden using KONDAS computer program developed for this purpose. It was possible to compute in a reliable manner both the low-frequency events of pulsating condensation, i.e. the formation of vapor bubbles and bubble collapsing, and to make predictions about the wall loads occurring in a multiple tube assembly.

37285 Nuclear reactor of the pressurized water type. Bideau, J.; Levy, J.; Viaud, J.L. (to Commissariat a l'Energie Atomique). US Patent 4,076,586. 28 Feb 1978. Priority date 2 Oct 1975, France. 14p.

In a pressurized water reactor, the pressure vessel contains a plurality of fuel wrappers of parallelepipedal section supported on a lower grid which carries projecting sleeves equal in number to the wrappers. Each sleeve penetrates into a bore of a wrapper base plate and has a higher coefficient of thermal expansion than the base plate so that its external diameter is smaller than that of the bore in the cold state and equal thereto at the operating temperature of the reactor. The bore is thus clamped against the sleeve as a result of thermal expansion, the fuel assemblies being secured within the wrappers by means of spring-type elastic devices. 12 claims, 14 figures.

37286 Industrial technique for an integral compact reactor. McDonald, B.N.; Schluderberg, D.C. (to Babcock and Wilcox Co.). US Patent 4,072,563. 7 Feb 1978. Filed date 24 Jun 1976. 10p.

A typical embodiment of an integral pressurized water nuclear reactor and straight-tube steam generator combination in accordance with the invention includes a generally cylindrical pressure vessel that is assembled from three segments which are bolted together at transverse joints to form a fluid and pressure tight unit that encloses the steam generator and the reactor. This novel construction permits primary to secondary coolant heat exchange and improved control rod drive mechanisms which can be exposed for full service access during reactor core refueling, maintenance and inspection. 5 claims, 2 figures.

37287 Method and apparatus for the zone-wise shuffling of nuclear reactor fuel elements. Neidl, H.; Kaspar, G.; Drossel, R. (to Simens Aktiengesellschaft). US Patent 4,072,559. 7 Feb 1978. Priority date 30 Nov 1972, German, Federal Republic of (F.R. Germany). 6p.

For zone-wise shuffling of the fuel elements of a nuclear reactor core, single ones of the elements, one after another, are removed sequentially, and immediately upon the removal of each element it is tested for cladding defects, and if free therefrom, immediately inserted back in its new position in the reactor core, elements having cladding defects being eliminated. An apparatus for the rapid testing of each removed element is provided by a testing chamber containing water in which the removed element is immersed and allowed to remain for a short time, the water then being removed and tested for gamma activity to determine the element's cladding integrity. Other features are disclosed. 4 claims, 3 figures.

37288 Mechanical and thermal analysis of oxide fuel rods. Hwang, I.; Lee, B.; Lee, C. *J. Korean Nucl. Soc.;* **9**: No. 4, 223-236(Dec 1977).

An integral computer code has been developed for a mechanical and thermal design and performance analysis of an oxide fuel rod in a pressurized water reactor. The code designated as FROD 1.0 takes into account the phenomena of radial power depression within the pellet, cracking, densification and swelling of the pellet, fission gas release, clad creep, pellet-clad contact, heat transfer to coolant, and buildup of corrosion layers on the clad surface. The FROD 1.0 code yields two-dimensional temperature distributions, dimensional changes, stresses, and internal pressure of a fuel rod as a function of irradiation time within a reasonable computation time. The code may also be used for the analyses of oxide fuel rods in other thermal reactors. As an application of FROD 1.0 the behavior of fuel rod loaded in the first core of Go-ri Nuclear Power Plant Unit 1 is predicted for the two power histories corresponding to steady state operation and Codition II of the ANS Classification. The results are compared with the design criteria described in the Final Safety Analysis Report and a discrepancy between these two values is discussed herein. 11 figures.

37289 Offshore power plants: still afloat. *Electr. World;* **188**: No. 4, 58-61(15 Aug 1977).

The origins of the floating nuclear power plant concept are described and current development efforts are reviewed.

37290 Shielding against neutron streaming in pressurized-water reactor. Devillers, C. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)); Payen, J.P. (Electricite de France, 75 - Paris). *Atomkernenergie;* **30**: No. 4, 275-281(1977).

From 5. international reactor shielding conference; Knoxville, Tenn. (18 - 22 Apr 1977).

4 figs.; 6 refs.

Computational techniques used to treat neutron and gamma streaming through the annular air gap around the vessel of a pressurized-water reactor are described. A practical shielding arrangement consisting of two layers of different hydrogenous materials is presented.

37291 **Floating nuclear power plants.** Zechella, A.P. *Mil. Eng.;* **69**: No. 451, 306-309(1977).

A review of the floating nuclear power plant concept is presented. Topics discussed include characteristics, advantages, safety considerations, siting alternatives, the site design envelope, and site selection.

POWER REACTORS, NON-BREEDING, GRAPHITE MODERATED

REFER ALSO TO CITATION(S) 37354, 37361, 37368

37292 (CEA-CONF—3924) **Fabrication of HTR fuel elements by a gaseous impregnation process.** Blin, J.C.; Berthier, J.; Devillard, J. (CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Dept. de Metallurgie). 25 Nov 1976. 7p. (In German). (CONF-770323—7). Dep. NTIS (US Sales Only), PC A02/MF A01.

From Reactor congress; Mannheim, F.R. Germany (29 Mar 1977).

The results obtained with the gaseous impregnation process are described. The successive steps of the fabrication in their present state of realization are given together with the results obtained after irradiation. A comparison between this process and a classical method is presented.

37293 (CEGB-RD/B/N—3988) **Determination of nuclear heating thermocoupled fuel pins in AGR instrumented stringers.** Dawson, J.T.; Smith, G. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). Apr 1977. 33p. Dep. NTIS (US Sales Only), PC A03/MF A01.

Mismatches in linear rating between standard and thermocoupled fuel pins in instrumented CAGR fuel clusters are minimised at start-of-life by choice of enrichment, but change with irradiation due to differential plutonium production and uranium depletion. Calculation of mismatches are assessed by comparison with gamma-scanning measurements on a Windscale AGR Mk 5 cluster. It is concluded that start-of-life calculations of relative linear ratings are accurate to +- 2% (1sigma), and that changes with irradiation are predicted to +- 25% (1sigma).

37294 (GA-A—14571) **Core design study for an advanced HTGR.** Baxter, A.M.; Iyer, P.A. (General Atomic Co., San Diego, Calif. (USA)). Feb 1978. Contract EY-76-C-03-0167-061. 88p. Dep. NTIS, PC A05/MF A01.

Advanced High Temperature Gas-cooled Reactor (HTGR) design concepts for energy production via gas turbine and process heat applications center on cores generating helium coolant outlet temperatures of up to 1000°C (1800°F). A preliminary analysis of a large HTGR core using a prismatic fuel with coolant gas core outlet temperatures of 950°C (1740°F) is presented. The purpose of this study was to provide detailed core design information in the areas of radial fuel zoning, power distribution, fuel performance, fuel temperatures, and fission product release for a large HTGR core operating under very high temperature conditions to identify potential problem areas and to suggest where improvements could be made in future design work.

37295 (GA-A—14721) **TRAFIC, a computer program for calculating the release of metallic fission products from an HTGR core.** Smith, P.D. (General Atomic Co., San Diego, Calif. (USA)). Feb 1978. Contract EY-76-C-03-0167-017. 188p. Dep. NTIS, PC A09/MF A01.

A special purpose computer program, TRAFIC, is presented for calculating the release of metallic fission products from an HTGR core. The program is based upon Fick's law of diffusion for radioactive species. One-dimensional transient diffusion calculations are performed for the coated fuel particles and for the structural graphite web. A quasi steady-state calculation is performed for the fuel rod matrix material. The model accounts for nonlinear adsorption behavior in the fuel rod gap and on the coolant hole boundary. The TRAFIC program is designed to operate in a core survey mode; that is, it performs many repetitive calculations for a large number of spatial locations in the core. This is necessary in order to obtain an accurate volume integrated release. For this reason the program has been designed with calculational efficiency as one of its main objectives. A highly efficient numerical method is used in the solution. The method makes use of the Duhamel superposition principle to eliminate interior spatial solutions from consideration. Linear response functions relating the concentrations and mass fluxes on the boundaries of a homogeneous region are derived. Multiple regions are numerically coupled through interface conditions. Algebraic elimination is used to reduce the equations as far as possible. The problem reduces to two nonlinear equations in two unknowns, which are solved using a Newton Raphson technique.

37296 (JAERI-M—7015) **Bibliographic survey of bearings for nuclear reactors.** Nemoto, M.; Okamoto, Y. (Japan Atomic Energy Research Inst., Tokyo). Mar 1977. 38p. (In Japanese). Dep. NTIS (US Sales Only), PC A08/MF A01.

In development of a multi-purpose high-temperature gas cooled reactor, design of its mechanical elements is essential. Machinery must be safely operable in the high temperature (1,000°C), high pressure (40kg/cm^2) helium environment for long time. A bibliographic review in this connection with technical reports, books, journals and patents, is presented, using NSA. As an element of the machinery bearings are classified into several categories, a bibliography on gas-lubricated bearings for 207 documents is given in chronical order.

37297 **Performance of thorium fuel cycles in the pebble-bed reactor.** Teuchert, E.; Ruetten, H.J.; Werner, H. (Kernforschungsanlage, Juelich, Ger.). *Nucl. Technol.;* **38**: No. 3, 374-383(May 1978).

For the pebble-bed high-temperature reactor, a wide choice is available for the design of the fuel elements and for the reactor fueling scheme. This flexibility has been utilized for the conception of different possibilities for the closure of the thorium fuel cycle. The easiest scheme is mixed-oxide recycling with repeated recycling of ^{236}U. Loading recycle fuel into separate elements without thorium reduces the uranium ore demand by 13%. Entire separation of the feed and breed circuits brings another reduction of 5%. Furthermore, the feed-breed cycle allows the production of ^{233}U for the near-breeder variant. This variant achieves a conversion ratio of 0.97, and it represents a possible choice for efficient protection of uranium ore resources. Within the span of uncertainties in the cost assumptions, fuel cycle costs are found to be comparable for all considered cycles, including the near-breeder.

37298 **Block fuel elements for high temperature power reactors.** Hackstein, K.G.; Hrovat, M.; Wolff, W. (to Nuken GmbH). US Patent 4,076,775. 28 Feb 1978. Priority date 15 Feb 1972, German, Federal Republic of (F.R. Germany). 10p.

Block fuel elements are prepared according to application Serial No. 218,244 of January 17, 1972, and now abandoned, from isotropic graphite granulates and coated fuel particles solely by pressing and without any mechanical processing. The cooling channels are pressed directly along with the other parts of the fuel elements. 11 claims, 4 figures.

37299 **Corrosion resistance of tubes for PWR steam generators.** Camona, G.A.; Quaglia, G.M. (Centro Informazioni Studi Esperienze, Milan (Italy)); Pascali, R.; Regis, V. (Ente Nazionale per l'Energia Elettrica, Milan (Italy)). *Energ. Nucl. (Milan);* **24**: No. 6, 306-326(Jun 1977). (In Italian).

From 22. nuclear congress; Rome, Italy (24 Mar 1977).

82 refs.

A large research activity is pursued by nuclear plant manufactures, electrical utilities and research institutes, in view of minimizing the incidence of corrosion phenomena occurring in PWR steam generators. A brief description is given in this paper of the phenomena, as well as the chemical-physical and metallurgical parameters of the corrosion processes which have been investigated on experimental loops simulating particular critical operating conditions. An analysis is also made of some laboratory characterization tests aimed at assessing the high nickel austenitic alloy susceptibility to specific corrosion forms, with particular reference to stress assisted corrosion cracking. With some experimental results obtained in the frame of an ENEL-EdF cooperation, the current research program jointly developed by ENEL and CISE on this subject is then presented. In this program use is made of an heat exchange loop entirely designed and constructed at CISE.

POWER REACTORS, NON-BREEDING, OTHERWISE MODERATED OR UNMODERATED

REFER ALSO TO CITATION(S) 37357, 37699

37300 **Ongoing tests check Candu corrosion.** Taylor, G.F. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). *Can. Chem. Process.;* **61**: No. 6, 25-26, 28(Jun 1977).

From Corrosion Forum/77; San Francisco, California, USA (Mar 1977).

Candensed version of paper. 2 refs.

For many years, corrosion of materials used in the primary coolant circuits of Candu power reactors has been measured at NPD. The experiments consist of autoclave loops with coupons of

various materials, and model boilers. Results of the experiments are reported, and some conclusions reached. For example, it has been found that ammonia is generally inferior to lithium hydroxide for pH control. Although Monel 400 (the material used in boilers at Pickering) shows excellent corrosion resistance at dissolved deuterium levels of 5 cm^3 D_2/kg D_2O, it has been found to be more corrodible than carbon steel at 0.5 cm^3 D_2/kg D_2O. Inconel-600 (used at NPD and Bruce) performs well and is insensitive to deuterium levels, but Incoloy-800 gives less activity transport.

POWER REACTORS, BREEDING

REFER ALSO TO CITATION(S) 37408, 37434, 37456, 37463, 37465, 37466, 37468, 37469, 37470, 37483, 37647

37301 (AI-DOE—13209) **Fast reactor fluence dosimetry. Technical progress report, June—December 1977.** (Atomics International Div., Canoga Park, Calif. (USA)). 31 Mar 1978. Contract EY-76-C-03-0824-027. 30p. Dep. NTIS, PC A03/MF A01.

The objectives of this task are to develop and demonstrate the use of ^{10}B and ^{6}Li helium accumulation fluence monitors (HAFM's) as a reliable and accurate method of measuring reactor neutron fluence, develop and apply an expanded set of HAFM's that will provide fluence responses in different but overlapping neutron energy ranges, and identify, through the precise measurement of spectrum-integrated helium production cross sections, those elements producing significant helium when used individually or as components of advanced alloys in FTR and breeder reactor neutron environments, so that their use might be eliminated, minimized, or controlled.

37302 (ANL—77-77) **Plane-strain stress intensity factors for cracked hexagonal subassembly ducts.** Petroski, H.J.; Glazik, J.L.; Achenbach, J.D. (Argonne National Lab., Ill. (USA)). Oct 1977. Contract W-31-109-ENG-38. 44p. Dep. NTIS, PC A03/MF A01.

Plane-strain stress intensity factors for a pressurized hexagonal subassembly duct with a crack in a corner or midflat are presented in convenient graphical form for representative LMFBR hexcan dimensions. Corner-crack calibrations based on several different models of the round hexcan corner are determined first in order to bound the stress intensity factor. A subsequent finite-element analysis of a uniformly pressurized hexcan with a corner crack gives accurate data for the stress intensity factor from which a weight function for this geometry may be constructed. The effects of different numbers of cracks, different locations for cracks, and different loading modes are discussed briefly, and some comments are made on the application of linear elastic fracture mechanics to cracked hexagonal ducts that have suffered a high degree of irradiation embrittlement.

37303 (ANL-CT—78-19) **NUBOW-3D (inelastic): a FORTRAN program for the static three-dimensional structural analysis of bowed reactor cores including the effects of irradiation creep and swelling.** McLennan, G.A. (Argonne National Lab., Ill. (USA)). Mar 1978. Contract W-31-109-ENG-38. 176p. .

NUBOW-3D is a special purpose FORTRAN computer program for the three-dimensional static structural time history analysis of symmetric sectors of LMFBR core systems, subjected to thermal and/or mechanical bowing and time (fluence) dependent effects of irradiation-induced swelling and irradiation-enhanced creep. The program calculates the mechanical equilibrium forces and displacements of the core system treating the individual assemblies as conventional beam members. Time increments of creep and swelling strains are calculated for each assembly using specified material creep and swelling correlations and input values for assembly flux and temperature distributions. These strains are numerically integrated over each assembly to give inelastic beam curvatures and bowed shapes. Assembly dilation and contact forces in the core region are calculated for each time step. Detailed strain and fluence histories, contact forces and displacements are calculated and stored for each time step in the history. Using input reactivity worth values for individual assemblies, the structural reactivity changes for the reactor system are calculated for each time step. The NUBOW-3D structural model allows for a..ial variations in assembly geometry and different types of assemblies in the system. Local flexibility and clearance gap may occur at all contact points. Contact stiffness is modeled as a single linear compression spring, acting after gap closure. Forces are assumed to act normal to contacting surfaces, so that friction and torsional effects are not included in the analysis.

37304 (ANL-CT—78-20) **Release of bubbles from small leaks at steam generator tubesheet welds.** Skladzien, S.B.; McKee, J.M. (Argonne National Lab., Ill. (USA)). Mar 1978. Contract W-31-109-ENG-38. 19p. .

Helium was injected into a water-filled Lucite mockup of the CRBR steam generator tubesheet region to simulate the hydrogen bubbles formed by a small steam leak into sodium at a tube-to-tubesheet weld. With the tubesheet horizontal (lower tubesheet orientation), the bubbles escaped upward through the $^1/_{16}$" (1.6 mm) annulus between the tubes and the 3" (76 mm) thick thermal baffle with no significant delay. With the tubesheet vertical (upper tubesheet orientation) the bubbles again escaped from the annulus and rose vertically through the gap between thermal baffle and tubesheet with minimal delay. The smallest leak that typically remains open, 10 mg H_2O/s, is expected to generate ample hydrogen to form a vigorous rising stream of bubbles. The total travel of these bubbles before dissolving is expected to be ample at the lower tubesheet and probably adequate at the upper (hotter) tubesheet to carry a local current of sodium rich in steam reaction products to the nearest leak detector. It is concluded that the thermal baffles and spacers will not significantly impede the prompt chemical detection of small steam leaks at tube-to-tubesheet welds in the CRBR hockey stick steam generator.

37305 (ANL-CT—78-21) **User's manual for finite-element computer code, CREEP-PLAST.** Yang, C.I.; Zawadzki, S. (Argonne National Lab., Ill. (USA)). Jan 1978. Contract W-31-109-ENG-38. 55p. Dep. NTIS, PC A04/MF A01.

CREEP-PLAST is a finite element computer code developed for high temperature structural design of LMFBR vessels, components and core structures. It performs creep and plasticity calculation in two dimensional form under plane stress, plane strain or axisymmetric assumptions. The original code has been extensively modified to improve its efficiency.

37306 (ANL-CT—78-24) **Pressure transient analysis in piping systems including the effects of plastic deformation and cavitation.** Youngdahl, C.K.; Kot, C.A.; Valentin, R.A. (Argonne National Lab., Ill. (USA)). Mar 1978. Contract W-31-109-ENG-38. 40p. Dep. NTIS, PC A03/MF A01.

Computational methods for analyzing pressure transients in the intermediate heat transport system of a sodium-cooled breeder reactor are being developed at Argonne National Laboratory. Because these systems typically operate at low pressures, thin-walled piping is used. Consequently, the pressure pulses produced by a sodium/water reaction in a steam generator or a pipe break may plastically deform sections of the piping, and rarefaction waves, because of the low operating pressure, may produce cavitation in the system. Both these phenomena have a large effect on the pressure pulses traversing the pipe network and, consequently, on the transient loading on major components. The computer program PTA-1, which includes the effect of plastic deformation of piping, and the computer program PTAC, which includes the effect of cavitation, have previously been validated using available experimental data. A new program, PTA-2, is being developed which combines the capabilities of PTA-1 and PTAC. Comparisons will be shown between PTA-2 predictions and the results of several experiments performed at Stanford Research Institute. In each of these experiments, a pressure pulse caused plastic deformation of a thin-walled pipe, producing a rarefaction wave which then produced a cavitated region in another pipe.

37307 (COO—2245-46TR) **Assessment of the need to incorporate the variable swirl model in the ENERGY code.** Basehore, K.L.; Todreas, N.E. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Nuclear Engineering). Jul 1977. Contract EY-76-S-02-2245. 74p. NTIS, MF A01.

Portions of document are illegible.

At present the ENERGY model contains a correlated swirl flow that is circumferentially and axially constant. This report evaluates the need to include a variable swirl flow forcing function in this model. A suitable function for testing the variable swirl flow effects is obtained by reducing the existing world transverse flow experimental data, relying heavily on the MIT laser doppler anemometer data. A comparison of the existing constant swirl model with the variable swirl model using the resulting forcing function is made with the help of a few sample problems.

37308 (COO—2477-16) **Capital cost: gas cooled fast reactor plant.** (United Engineers and Constructors, Inc., Philadelphia, Pa. (USA)). Sep 1977. Contract EY-76-C-02-2477. 411p. Dep. NTIS, PC A18/MF A01.

The results of an investment cost study for a 900 MW(e) GCFR central station power plant are presented. The capital cost estimate arrived at is based on 1976 prices and a conceptual design only, not a mature reactor design.

37309 (GEFR—10028-64) **Core engineering. Sixty-fourth quarterly report, August—October 1977.** (General Electric Co., Sunnyvale, Calif. (USA). Fast Breeder Reactor Dept.). Nov 1977. 45p. .

Information is presented concerning LMFBR fuel assembly engineering and core component design analysis.

37310 (GEFR-SP—053) **CRBR pump design concepts and resultant design evolution.** Manners, L. (General Electric Co., Sunnyvale, Calif. (USA)). 1977. Contract EY-76-C-03-0893-001. 16p. .

US—ERDA/Japanese-PNC seminar on LMFBR components, December 1977. Portions of document are illegible.

The design, model testing, and fabrication status of the primary sodium pumps for the Clinch River Breeder Reactor are discussed.

37311 (IWGFR—8) **Ninth annual meeting, Vienna, Austria, 30 March—2 April 1976. Summary report. Part I.** (International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors). Jun 1976. 26p. (CONF-760396—P1(summ.)). Dep. NTIS (US Sales Only), PC A03/MF A01.

From 9. meeting of the international working group on fast reactors; Vienna, Austria (30 Mar 1976).

This document constitutes the summary report of the Ninth Annual Meeting of the International Working Group on Fast Reactors.

37312 (IWGFR—9, pp 87-89) **Erosion by cavitation in the diffuser of a mechanical pump.** Cochet, J.C.; Schaller, K.H. Jun 1976.

From Specialist meeting on cavitation in sodium and studies of analogy with water as compared to sodium; Cadarache, France (12 Apr 1976).

In Specialists meeting on cavitation in sodium and studies of analogy with water as compared to sodium, Cadarache, France, April 12-16, 1976. Summary report.

37313 (IWGFR—9, pp 107) **Detection and evaluation of the development of cavitation by direct listening of the ultrasonic field with the help of an heteridyne frequency shifting system.** Danel, F.; Lecoffre, Y. Jun 1976.

From Specialist meeting on cavitation in sodium and studies of analogy with water as compared to sodium; Cadarache, France (12 Apr 1976).

In Specialists meeting on cavitation in sodium and studies of analogy with water as compared to sodium, Cadarache, France, April 12-16, 1976. Summary report.

37314 (IWGFR—9, pp 75-78) **Cavitation problems in sodium valves.** Elie, X. Jun 1976.

From Specialist meeting on cavitation in sodium and studies of analogy with water as compared to sodium; Cadarache, France (12 Apr 1976).

In Specialists meeting on cavitation in sodium and studies of analogy with water as compared to sodium, Cadarache, France, April 12-16, 1976. Summary report.

Cavitation poses few problems for sodium valves in spite of the fact that the loops are not pressurized. This is no doubt due to the low flow velocities in the pipes. For auxiliary loop valves no attempt is made to standardize performances with respect to cavitation. For economic reasons cavitation thresholds are approached with large diameter valves.

37315 (IWGFR—9, pp 9-24) **Cavitation problems in mixing devices of SNR-300 fuel elements.** Benemann, A. (Internationale Atomreaktorbau G.m.b.H. (INTERATOM), Bensberg/Koeln (Germany, F.R.)). Jun 1976.

From Specialist meeting on cavitation in sodium and studies of analogy with water as compared to sodium; Cadarache, France (12 Apr 1976).

In Specialists meeting on cavitation in sodium and studies of analogy with water as compared to sodium, Cadarache, France, April 12-16, 1976. Summary report.

Because of a complex flow path within the mixing device developed for the fuel elements of the SNR-300, in order to determine the minimum allowable interval to the beginning of cavitation, experimental tests with the original geometry are necessary. These conclusions show that for cavitation values CV>=1,3 - in the model and prototype - no cavitation zones can form. For reactor conditions a maximum velocity of Vsub(max)=4,7m/sec is therefore allowable in the free annular space of the compensator unit which corresponds to a massflow of M=22,5kg/sec. A cavitation value of CV=1,5 can be figured for the 120% load factor (M=20,4kg/sec,T=560°C). The mixing device developed is free of cavitation under the present conditions in the SNR-300.

37316 (IWGFR—9, pp 25-33) **Cavitation problems in fast reactor fuel subassemblies.** Bisci, R.; Muret, G.; Teulon, J. Jun 1976.

From Specialist meeting on cavitation in sodium and studies of analogy with water as compared to sodium; Cadarache, France (12 Apr 1976).

In Specialists meeting on cavitation in sodium and studies of analogy with water as compared to sodium, Cadarache, France, April 12-16, 1976. Summary report.

The main reasons are presented why sodium flow in Fast Reactors must be free from cavitation phenomena. Fuel subassembly cavitation problems are described and especially those encountered with flow regulation systems. The choice of a cavitation criterion is discussed: it is assumed that the beginning of cavitation in sodium flow can be extrapolated from measurements on water mock-ups. It is also assumed that the Thoma Number, which characterizes the beginning of cavitation, is strictly independant of the fluid nature.

37317 (IWGFR—9, pp 92-94) **Cavitation work conducted at Risley engineering and materials laboratories.** Collinson, A.E. (UKAEA). Jun 1976.

From Specialist meeting on cavitation in sodium and studies of analogy with water as compared to sodium; Cadarache, France (12 Apr 1976).

In Specialists meeting on cavitation in sodium and studies of analogy with water as compared to sodium, Cadarache, France, April 12-16, 1976. Summary report.

37318 (IWGFR—9, pp 94-101) **NERATOOM work on pump development.** Hoornweg, C.J. (Neratoom N.V., The Hague (Netherlands)). Jun 1976.

From Specialist meeting on cavitation in sodium and studies of analogy with water as compared to sodium; Cadarache, France (12 Apr 1976).

In Specialists meeting on cavitation in sodium and studies of analogy with water as compared to sodium, Cadarache, France, April 12-16, 1976. Summary report.

The prototype pump has been manufactured by Stork Engineerings Works at Hengelo in 1969. The full-scale test on water has been carried out as part of the procedures of acceptance. Tests on sodium have been carried out in the pumptestfacility of Interatom at Bensberg (W. Germany); these tests started in March 1971 and were finished in October 1972. During that period nearly 6000 hours of pump testing were accomplished, of which 150 hours the pump was subjected to a cavitation intensity of more than 3% loss of delivery head.

37319 (IWGFR—9, pp 41-45) **Flowrate regulation device in PEC reactor fuel element.** Tirelli, D. (Comitato Nazionale per l'Energia Nucleare, Bologna (Italy). Programma Reattori Veloci). Jun 1976.

From Specialist meeting on cavitation in sodium and studies of analogy with water as compared to sodium; Cadarache, France (12 Apr 1976).

In Specialists meeting on cavitation in sodium and studies of analogy with water as compared to sodium, Cadarache, France, April 12-16, 1976. Summary report.

A calculation method which optimizes a series of sharp-edged constrictions has been defined to design the PEC reactor fuel element foot and can device. Total pressure drop is divided in each gag to obtain equal cavitation numbers in vena contracta planes. Water and sodium experimental tests have been carried out for most critical configurations; pressure drop results agree the prediction, while cavitation results are a little spread; some instrumental and modelling improvement activities are now being developed to reduce this uncertainty to physical-chemical sodium condition variables in the reactor.

37320 (IWGFR—9, pp 89-92) **Effect of pump cavitation on the design of the primary pumps for C.F.R.** Worster, R.C. (Weir Pumps Ltd., Alloa (UK)). Jun 1976.

From Specialist meeting on cavitation in sodium and studies of analogy with water as compared to sodium; Cadarache, France (12 Apr 1976).

In Specialists meeting on cavitation in sodium and studies of analogy with water as compared to sodium, Cadarache, France, April 12-16, 1976. Summary report.

In the design appraisal of the sodium pumps for the primary circuit of the proposed 1300 MW(e) CFR it has been recognised that cavitation, its effects and its control, is the outstanding hydraulic design problem. Careful consideration of this problem and of the possible effects of pump cavitation on the performance of other reactor systems has led to the conclusion that it is more prudent at present to specify pumps with zero cavitation at normal full speed operating conditions. Under abnormal operation it may be necessary to reduce the pumps' speed to prevent cavitation in the pumps or associated equipment. The principal reasons for this decision were uncertainties concerning the possibility of erosion due to limited cavitation in sodium and the possibility of pump cavitation noise interfering with acoustic detection of malfunctioning of reactor components or of boiling in the reactor core.

37321 (IWGFR—12, pp 26-32) **Present state of development of the fast breeder project in the Federal Republic of Germany, Belgium and the Netherlands, and progress achieved during 1975 and early 1976.** Daeunert, U.; Kessler, G. Nov 1976.

From 9. meeting of the international working group on fast reactors; Vienna, Austria (30 Mar 1976).

In Ninth annual meeting, Vienna, Austria, 30 March—2 April 1976. Summary report. Part II and part III.

This report outlines the present state of development of the fast breeder project in the Federal Republic of Germany, Belgium and the Netherlands.

37322 (IWGFR—12, pp 19-25) **Review of fast reactor activities in Italy, March 1976.** Pierantoni, F. Nov 1976.

From 9. meeting of the international working group on fast reactors; Vienna, Austria (30 Mar 1976).

In Ninth annual meeting, Vienna, Austria, 30 March—2 April 1976. Summary report. Part II and part III.

This paper outlines the development of the fast reactor program in Italy. The main areas concerned are: sodium and components technology, reactor core, reactor physics, safety, strategy and economy studies.

37323 (IWGFR—12, pp 1-13) **Review of fast reactor progress in the UK, March 1976.** Smith, R.D. Nov 1976.

From 9. meeting of the international working group on fast reactors; Vienna, Austria (30 Mar 1976).

In Ninth annual meeting, Vienna, Austria, 30 March—2 April 1976. Summary report. Part II and part III.

This paper describes briefly the fast reactor progress in the United Kingdom. A review on the following topics is given: the prototype fast reactor (PFR), the design of the commercial fast reactor (CFR), the fast reactor fuel, the safety and sodium technology.

37324 (IWGFR—12, pp 13-18) **Review of fast reactor progress in Japan, March 1976.** Tomabechi, K.; Hosaka, A. Nov 1976.

From 9. meeting of the international working group on fast reactors; Vienna, Austria (30 Mar 1976).

In Ninth annual meeting, Vienna, Austria, 30 March—2 April 1976. Summary report. Part II and part III.

This paper describes briefly the fast reactor program in Japan. Specifications on MONJU and JOYO fast reactors are given.

37325 (IWGFR—12, pp 33-44) **Development of French programme on fast reactors, from March 1975 to March 1976.** Vautrey, L. Nov 1976.

From 9. meeting of the international working group on fast reactors; Vienna, Austria (30 Mar 1976).

In Ninth annual meeting, Vienna, Austria, 30 March—2 April 1976. Summary report. Part II and part III.

This paper describes the main features of the French program on fast reactors: Super Phenix, Rapsodie and Phenix.

37326 (IWGFR—12, pp 44-87) **Status of the U.S.A. liquid metal fast breeder programme, April 1976.** Wensch, G.W. Nov 1976.

From 9. meeting of the international working group on fast reactors; Vienna, Austria (30 Mar 1976).

In Ninth annual meeting, Vienna, Austria, 30 March—2 April 1976. Summary report. Part II and part III.

This report is a summary of the major projects and activities of the high priority U.S. liquid metal fast breeder reactor program.

37327 (JAERI-M—6993) **Calculation program for fast reactor design, 2. Multi-dimensional perturbation theory code based on diffusion approximation: PERKY.** Iijima, S.; Yoshida, H.; Sakuragi, H. (Japan Atomic Energy Research Inst., Tokyo). Feb 1977. 51p. (In Japanese). Dep. NTIS (US Sales Only), PC A04/MF A01.

The program PERKY is used for calculating reactivity worth and kinetic parameters of a fast breeder reactor by ordinary first-order or exact perturbation theory based on two- or three-dimensional diffusion approximation. It calculates effective delayed neutron fraction, prompt neutron lifetime and nuclide reactivity worth mapping using microscopic cross-sections, and also reactivity change using microscopic or macroscopic cross-sections. The anisotropic effect of leakage on the reactivity change calculated by using macroscopic cross-sections can be estimated with bidirectional, diffusion coefficients calculated from the Bensist formulation. The real and adjoint neutron fluxes for perturbation calculations may be generated by multi-dimensional diffusion code CITATION, and the microscopic and macroscopic cross-sections be provided by effective cross-section generating code PIGEON.

37328 (JAERI-M—7067) **Space dependent kinetics codes by synthesis method.** Izutsu, S.; Hirakawa, H. (Japan Atomic Energy Research Inst., Tokyo). Apr 1977. 61p. (In Japanese). Dep. NTIS (US Sales Only), PC A04/MF A01.

A space time synthesis code and a time synthesis code have been developed for the continuous synthesis equations derived from the functional of the two-dimensional time dependent diffusion equation. The matrix factorization method is used in the former code; the solution is obtained effectively. Matrix equations to be solved are first derived from the basic equations. Usage of the codes is then given. And, results of the codes applied to the fast reactor model (international benchmark problem) are compared with those by other institutions; effectiveness of the codes is examined.

37329 (NIIAR-P—4(270)) **Two-dimensional model of a large power sodium-cooled fast breeder reactor with an oxide fuel for test calculations.** Zizin, M.N.; Kudryashov, L.N.; Nikolaev, M.N. (Nauchno-Issledovatel'skij Inst. Atomnykh Reaktorov, Dimitrovgrad (USSR)). 1976. 33p. (In Russian). Dep. NTIS (US Sales Only), PC A03/MF A01.

The suggested two-dimensional model of a fast breeding reactor is intended for performing comparative test calculations aimed at the comparison between the reactor characteristics calculated with the aid of the programmes and the constants employed in various research centres. The model corresponds to the reactor of the nuclear power plant with an electric power of 1500 MW. The technique of employing the model for testing is presented. The system of 6-group constants is proposed and the method of dividing the reactor volume by means of the end-difference grid for the basic calculations is shown. The initial data for the basic calculations has been the system of 26-group constants with regard to the changes in the group cross-sections of the main fissionable isotopes.

37330 (NUREG/CR—0016) **Parameter sensitivity study in the dynamic simulation of a sodium cooled breeder reactor power plant.** Kolb, G.J. (Arizona Univ., Tucson (USA). Coll. of Engineering). Jan 1978. 71p. NTIS $5.25.

Thesis.

The time domain sensitivity measure, peak sensitivity, was employed in studying the dynamics of a Clinch River Breeder Reactor Power Plant (CRBRP) digital simulator. With its use the most "safety sensitive" parameters in the plant model were identified for particular anticipated transients. Examples of such parameters include the Doppler feedback coefficient, fraction of power generated in the core, and the two phase flow friction multiplier. A method of putting first order bounds on a particular power plant transient due to parameter estimate error is also presented. This information is valuable since the CRBRP simulator was constructed with the intent of studying the safety of the system.

37331 (ORO—5273-1) **Suspended-Bed Reactor preliminary design, ^{233}U—^{232}Th cycle. Final report (revised).** Karam, R.A.; Alapour, A.; Lee, C.C. (Georgia Inst. of Tech., Atlanta (USA). School of Nuclear Engineering). Nov 1977. Contract EY-76-S-05-5273. 230p. Dep. NTIS, PC A11/MF A01.

The preliminary design Suspended-Bed Reactor is described. Coated particles about 2 mm in diameter are used as the fuel. The coatings consist of three layers: (1) low density pyrolytic graphite, 70 μ thick, (2) silicon carbide pressure vessel, 30 μ thick, and (3) ZrC layer, 50 μ thick, to protect the pressure vessel from moisture and oxygen. The fuel kernel can be either uranium-thorium dicarbide or metal. The coated particles are suspended by helium gas (coolant) in a cluster of pressurized tubes. The upward flow of helium fluidizes the coated particles. As the flow rate increases, the bed of particles is lifted upward to the core section. The particles are restrained at the upper end of the core by a suitable screen. The overall particle density in the core is just enough for criticality condition. Should the helium flow cease, the bed in the core section will collapse, and the particles will flow downward into the section where the increased physical spacings among the tubes brings about a safe shutdown. By immersing this section of the tubes in a large graphite block to serve as a heat sink, dissipation of decay heat becomes manageable. This eliminates the need for emergency core cooling systems.

37332 (PNC-N—251-76-12(Vol.1), pp 363-380) **Injection of sodium into liquid stainless steel. A report of the second experiment Na-SS/1.** Abbey, M.J.; Asher, R.C.; Bradshaw, L.; Davies, D.; Sangwine, S.J. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). 1976.

From 3. specialists' meeting on sodium fuel interaction; Tokyo, Japan (Mar 1976).

Also published in AERE-M--2771.

In Proceedings of the third specialist meeting on sodium/fuel interaction in fast reactors.

A second experiment in which liquid sodium was injected beneath the surface of molten steel has been carried out using an experimental technique based on that described in AERE - M 2770 but incorporating several improvements particularly in the instrumentation. The sodium (-- 1.5 g) was at 400 - 450°C and the steel (stainless steel in this instance) was at 1750 - 1800°C. A vapour explosion occurred after a measured dwell time and two force pulses $>$ 100 N and 60 N, separated by an interval of -- 1 ms were transmitted to the base of the crucible containing the molten steel. Most of the sodium 'vapourized' but only a minor part of the steel was converted into small particles.

37333 (TID—28194) **Prototype Large Breeder Reactor: Phase II extension. Volume I. Conceptual design studies.** (Bechtel Corp., San

Francisco, Calif. (USA)). Sep 1977. Contract EY-76-C-03-1144. 345p. .

The document is a compilation of an extension of the work done during Phase II of the ERDA/Electric Power Research Institute (EPRI) Prototype Large Breeder Reactor (PLBR) study. The objective of this Phase II extension was to investigate key engineering problems generic to the balance-of-plant for the loop concept which were identified during the Phase II effort. Included are the following reports which present the results of these investigations: (1) piping seismic restraint design for intermediate sodium piping between buildings (BTR-9); (2) containment building structural concept study (BTR-11); (3) heat transport system piping reliability enhancement study (BTR-12); (4) minimization of seismic loadings on components (BTR-13); and (5) heat transport cell liner design requirements (BTR-14).

37334 Effect of finite plant life on the doubling time of a breeder reactor population. Lee, S.M. (Reactor Research Center, Tamilnadu, India). *Nucl. Technol.;* **38**: No. 3, 384-386(May 1978).

When very large values are obtained for the doubling time of a breeder reactor type, it becomes interesting to see how the finiteness of the lifetime of a reactor plant affects the growth of a breeder population. A possible effect is the time lag between expiration of one plant and start of operation of its replacement plant. An analytical expression for the necessary correction to the compound system doubling time of the reactor population can be derived. Numerical examples show that in realistic cases, correction to the compound system doubling time will be small.

37335 Determination of reactivity from power spectral density measurements with ^{252}Cf. Mihalczo, J.T.; Pare, V.K.; Ragan, G.L.; Mathis, M.V.; Tillett, G.C. (Oak Ridge National Lab., TN). *Nucl. Sci. Eng.;* **66**: No. 1, 29-59(Apr 1978).

The theory of a method of determination of reactivity from power spectral density measurements with ^{252}Cf and the results of experiments with a critical assembly mockup of a liquid-metal fast breeder reactor (LMFBR) and with uranium (93.2 wt % ^{235}U) metal cylinders and a sphere are presented. This method of reactivity determination has an advantage over existing methods in that it determines the reactivity only from properties of the reactor at the subcritical state of interest and thus does not require a calibration near delayed criticality. In these experiments, the reactivity was varied by changing the fissile loading or the amount of neutron absorber inserted; for the LMFBR mockup, the reactivity varied to approximately 75 dollars subcritical, and for the uranium metal assemblies to approximately 30 dollars subcritical. These experiments verified for the first time the predictions of theory that could be tested in the measurements. This method has potential use in the fuel loading of reactors to determine the reactivity far subcritical before initial criticality is achieved. It has the advantage of not requiring a calibration at known reactivity by another method; furthermore, the interpretation of the measured data to obtain the reactivity does not depend on relative or absolute values of the source intensity or detection efficiency. It can also be used to determine the reactivity of assemblies where loading to criticality is undesirable or where sufficient material to achieve criticality is not available.

37336 Calculation of the reactivity due to bubble collapse with the probability table method. Hoffman, T.J.; Petrie, L.M. (Oak Ridge National Lab., TN). *Nucl. Sci. Eng.;* **66**: No. 1, 67-74(Apr 1978).

The probability table method, originally developed for unresolved resonance calculations, is adapted to the calculation of bubble worths in a reactor core. Unlike previous approaches to this problem, this method is applicable to a broad class of problems, avoids a high variance Monte Carlo calculation, and preserves the main features of a random bubble distribution. This approach is illustrated by the solution to several problems of varying degrees of complexity.

37337 Fuel assembly for gas-cooled nuclear reactors. Peehs, M.; Huenner, M. (to Kraftwerk Union AG). US Patent 4,077,839. 7 Mar 1978. Priority date 28 Sep 1973, German, Federal Republic of (F.R. Germany). 4p.

The individual fuel rods of a fuel assembly are connected to a fission gas exhaust system via perforated end caps. For this purpose, the perforated end caps are provided with external threads and screwed into a rod holding plate of the fuel assembly. In addition to the attachment thus provided, a tight connection to the canals of the fission gas exhaust system, which are built into the rod holding plate, is accomplished thereby at the same time.

37338 Nuclear reactor with self-orificing radial blanket. Bishop, A.A.; Weiss, E.H.G.; Engel, F.C. (to Westinghouse Electric Corp.). US Patent 4,077,835. 7 Mar 1978. Filed date 29 Apr 1975. 6p.

The peripheral blanket of a breeder reactor requires a coolant flow rate which is a varying fraction of that of the central core region. A self-orificing blanket cooling structure which is characterized by a predominance of radial coolant flow, generated by the pressure difference across the blanket, is utilized to supply the necessary cooling. The blanket fuel assemblies are surrounded by perforated cans to allow for radial crossflow through the blanket region.

37339 Method of continuous testing for leak-tightness and mechanical resistance of a reactor vessel jacket and a reactor in which said method is employed. Cachera, P.C. (to Electricite de France (Service National)). US Patent 4,076,585. 28 Feb 1978. Priority date 7 Sep 1973, France. 4p.

The space formed between the primary vessel of a sodium-cooled fast reactor and a leak jacket surrounding the vessel is filled with an inert gas which is maintained at a pressure in the vicinity of atmospheric. A vacuum is created within the space formed between the leak jacket and the concrete reactor vault and means are provided for detecting the presence of inert gas within the evacuated space and thus continuously testing the jacket for leak-tightness and mechanical resistance. 4 claims, 1 figure.

37340 Articulate fuel assembly. Noyes, R.C. (to Combustion Engineering, Inc.). US Patent 4,075,058. 21 Feb 1978. Filed date 8 Mar 1976. 8p.

An articulated fuel assembly for the core of a fast spectrum reactor comprising an elongated shroud enclosing a cluster of fuel pins, a support foot assembly supporting the fuel assembly in the reactor core and an articulating connector link joining the support foot assembly and the lower end of the elongated shroud is described. The upper end of the elongated shroud and the support foot assembly are adapted to be fixedly restrained against lateral movement when the assembly is placed in the reactor core. The articulating connector link is such as to permit free lateral deflection of the lower end of the shroud relative to the upper end of the shroud and the foot assembly. Such an arrangement icreases the reliability of the fuel assembly and safely accommodates the physical distortions in the fuel assemblies caused by neutron induced swelling of the members and thermally induced expansions thereof by reducing stresses in the structural parts of the assembly and by insuring a negative reactivity for the core as the lower ends of the fuel assemblies are laterally displaced. 4 claims, 4 figures.

37341 Manipulation of scientific data for nuclear energy calculations. Montgomery, K.R. pp 160-165 of Generalized data management systems and scientific information. Paris; OECD Nuclear Energy Agency (1978).

From OECD/NEA working group on nuclear information; Berkeley, CA, USA (5 Oct 1977).

See CONF-771062—.

Fuel management strategy is vital to the efficient operation of the PFR at Dounreay. The strategy encompasses planning, operational, and post-operational activities. Fuel management calculations are outlined for these stages of operation. The unusual nature of the associated problems, the ideal requirements of the system to be adopted, and the present technique for their solution are given. Some of the essential requirements of a scientific data base to support these calculations are defined. (RWR)

37342 Databank for the prototype fast reactor. Montgomery, K.R. pp 250-256 of Generalized data management systems and scientific information. Paris; OECD Nuclear Energy Agency (1978).

From OECD/NEA working group on nuclear information; Berkeley, CA, USA (5 Oct 1977).

See CONF-771062—.

This databank is a large set of files controlled by a management suite of COBOL data handling programs. The data, data dictionary and data directory are stored on exchangeable disc packs in the Random Access Index Sequential mode on an ICL 4/72 computer at the UKAEA headquarters at Risley. It is a databank for the UKAEA Prototype Fast Reactor which stores data pertaining to the entire composition of the in-core components, concentrating particularly upon the fissile fuelled driver assemblies and the many experimental assemblies of both fuel pin and cladding/structural materials. When the reactor is operating at full power the databank will contain reactor operating history and reactor physics data, and also post-irradiation examination data for the discharged units. The databank will represent a complete data compilation of in-reactor performance of fully documented materials. The current size of the databank is of the order of 100 megabytes and is expected to increase to approximately 200 megabytes over the next 2 years.

37343 Corrosion of steels in molten sodium hydroxide. Newman, R.N.; Smith, C.A.; Smith, R.J. (Berkeley Nuclear Labs., Eng.). *J. Electrochem. Soc.;* **124**: No. 8, 1247-1252(Aug 1977).

The role of sodium hydroxide corrosion is discussed in relation to the wastage of materials observed in fast reactor boilers under fault conditions in the vicinity of a water leak into sodium. An experimental technique to study the corrosion under varying conditions is described. The results presented are for 2¼ Cr-1Mo obtained in static sodium hydroxide in a closed volume over the

temperature range 1033°—1273°K. It is found that the corrosion rate can be followed by monitoring the hydrogen produced by the reaction, which can be written as $Fe + 2NaOH = NaFeO_2 + NaH + \frac{1}{2} H_2$. After an initial acceleration period the rate law is parabolic. The effect on the corrosion rate of melt and cover gas composition has been in part investigated, and the relevance of mass flow of reactant is discussed.

REGULATION AND LICENSING

37344 (NUREG/PRDI—78/4) **Power Reactor Docket Information.** (Nuclear Regulatory Commission, Washington, D.C. (USA)). Apr 1978. 105p. TIC $4.50.

Citations and subject indexing to the documentation associated with civilian nuclear power plants are presented. This material is that which is submitted to the U.S. Nuclear Regulatory Commission in support of applications for construction and operating licenses. Citations are listed by Docket number in accession number sequence. The Table of Contents is arranged both by Docket number and by nuclear power plant name.

37345 (NUREG/PRDI—78/5) **Power Reactor Docket Information.** (Nuclear Regulatory Commission, Washington, D.C. (USA)). May 1978. 99p. TIC $4.50.

Citations and subject indexing to the documentaton associated with civilian nuclear power plants are presented. This material is that which is submitted to the U.S. Nuclear Regulatory Commission in support of applications for construction and operating licenses. Citations are listed by Docket number in accession number sequence. The Table of Contents is arranged both by Docket number and by nuclear power plant name. (DG)

37346 III German Symposium on nuclear law held in Goettingen. Ghersini, F. (Pool Italiano per l'Assicurazione dei Rischi Atomici). pp 99-102 of Meeting on nuclear law. Rome; CISDEN (1976). (In Italian)

From Meeting on nuclear law; Rome, Italy (24 Nov 1975). See CONF-7511142—.

The Third German Symposium on Nuclear Law was oranised by the Institute for Public International Law of Goettingen University and the German Federal Ministry of the Interior. The topics dealt with covered legal problems in the licensing procedure for nuclear installations, technical rules and guidelines concerning reactor safety, the Treaty on the Non-Proliferation of Nuclear Weapons and related verification agreements, third party liability for nuclear incidents and finally, financial security and State intervention in the context of the German Bills to ratify the nuclear conventions and the amendments to the German Atomic Energy Act, in particular concerning third party liability for nuclear incidents.

37347 Ideas suggested by the Nuclear Inter Jura Congress 1975 at Aix-en-Provence. Nocera, F. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). pp 43-50 of Meeting of nuclear law. Rome; CISDEN (1976). (In Italian)

From Meeting on nuclear law; Rome, Italy (24 Nov 1975). See CONF-7511142—.

The increasing importance of nuclear law in the sphere of juridical disciplines is stressed, in particular, as illustrated by various contributions among the ones presented at the Congress, which took place from 29 September to 3 October 1975, by the experts of countries and organizations. The Italian papers deal with the problems raised by the construction of off-shore nuclear power plants and the recent development of the national nuclear legislation, the US papers refer to the current problems, due to potential conflicts between nuclear legislation and that of other connected sectors; the great importance of the juridico-administrative aspects connected with the processing and disposal of radioactive wastes were recalled by the Dutch expert, in the framework of the wider regulations for the protection of the environment; emphasis is given to the originality and at the same time the practical importance of the questions dealt with by the NEA expert on the subject of modifications to nuclear plants in the course of operation, with particular regard to the problem of possible compensation for the operator.

37348 Legal position of the operator and the constructor as regards construction of a nuclear power plant. Sartorelli, C. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). pp 11-28 of Meeting on nuclear law. Rome; CISDEN (1976). (In Italian)

From Meeting on nuclear law; Rome, Italy (24 Nov 1975). See CONF-7511142—.

Implementation of the Italian nuclear power programme requires that ENEL (the Italian State Electricity Agency) should solve a series of problems which are not only political, technical and financial, but also legal. The latter include the different positions held by constructors and operators in the nuclear law field. Although the operator must necessarily entrust construction work by contract to specialized agencies, the constructor as a person proper is completely ignored by the legislation in force, while the operator, as the holder of the construction licence is responsible with regard to all the provisions concerning controls, tests, inspections, etc. In recent years ENEL has frequently concluded "turnkey" contracts, but in future, given the desirability of diversifying the orders, ENEL may adopt a different policy, and negotiate different contracts with the suppliers of various components.

37349 Harmonized technical standards in the nuclear field. Carbone, F. (Centro Italiano di Studi di Diritto dell'Energia Nucleare, Rome). pp 37-42 of Meeting on nuclear law. Rome; CISDEN (1976). (In Italian)

From Meeting on nuclear law; Rome, Italy (24 Nov 1975). See CONF-7511142—.

The need was felt of harmonizing and gradually standardizing technical norms, from the well-known Anglo-Saxon type codes of practice to the equally well-known recommendations of the International Commission on Radiological Protection (ICRP). The latter provide the basis for the Euratom Directives (basic standards), which, following their adoption, were embodied in the national laws of community Member countries. ISO (International Standardization Organization) is active in the nuclear technical regulations field, in particular through its Committee ISO/TC 85 "Nuclear Energy" at international level and, in Italy, through the National Italian Unification Agency (UNI) and its Nuclear Unification Commission (UNICEN). At its XI plenary meeting this body, on the proposal of the Secretary-General, set up a Study Group to promote revision of the regulation in force and coordination between legislation and development of UNICEN standards, considered as a set of integrative industrial technical standards. CISDEN, the Italian Nuclear Energy Forum (FIEN) and other interested organizations have been invited to collaborate in this work.

37350 Accumulation of obligations as regards the utilization of radioactive materials according to the regulations in force. Pizzi, L. (Fiat, Turin (Italy). Sezione Energia Nucleare). pp 29-36 of Meeting on nuclear law. Rome; CISDEN (1976). (In Italian)

From Meeting on nuclear law; Rome, Italy (24 Nov 1975). See CONF-7511142—.

The administrative formalities imposed by Italian regulations concerning the industrial use of radioisotopes and radiation sources are considerable indeed. Experience in the practical application of these regulations these past years tends to show that advantages could be gained by revising them in the light of such experience. The Italian Centre for Study of nuclear law (CISDEN) seems to be an appropriate forum for this revision.

37351 London Conference on the existing nuclear insurance regime in relation to international conventions and national legislation on nuclear third party liability. Albano, R. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). pp 51-97 of Meeting on nuclear law. Rome; CISDEN (1976). (In Italian)

From Meeting on nuclear law; Rome, Italy (24 Nov 1975). See CONF-7511142—.

In view of the impetus given to nuclear power development as a result of the oil crisis, the US Atomic Industrial Forum and the British Nuclear Forum sponsored an International Conference in London on nuclear insurance and indemnity, to consider the existing nuclear insurance regime and to discuss possible amendments in the light of this situation. Following a review of the problems raised by the international nuclear liability conventions, namely, the Paris Convention, the Vienna Convention, the Brussels Convention on nuclear ship operators and their relationship with national nuclear third party liability legislation, the European and United States insurance markets and organisation of insurance pools were discussed, with emphasis on the problems stemming from maritime transport of nuclear substances, off-shore plants, reprocessing plants, nuclear parks, nuclear-powered ships. Finally, nuclear third party liability legislation and insurance in the United States, France, the Federal Republic of Germany, the United Kingdom, Sweden and Canada were reported in detail.

REACTOR DOCKETS

37352 (DOCKET-50298—1006) **Cooper Nuclear Station. Applicant's annual operating report, 1 January—31 December 1977.** (Nebraska Public Power District, Columbus (USA)). 1 Mar 1978. vp.

After a chronological summary of plant operations and plant outages or power reductions, data are presented concerning performance, vessel transient condition events, fuel performance, changes, maintenance, and personnel and man/rem by work and job function. (FS)

ECONOMICS

CONSTRUCTION AND OPERATION

REFER ALSO TO CITATION(S) 37308

37353 Role of nuclear energy in the more efficient exploitation of fossil fuel resources. Seifritz, W. (Swiss Federal Inst. for Reactor Research, Wuerenlingen). *Int. J. Hydrogen Energy;* **3**: No. 1, 11-20(1978).

The energy theory of value, being a valuable addition to the debate on the rational exploitation of man's energy reserves, is applied in order to clarify the presently confused energy input/output relations for nuclear and solar systems as they interact with fossil fuel. It is shown on the basis of purely energetics considerations that the nuclear route--at present and in future--is a very efficient way to stretch out and finally to substitute for the limited fossil fuel resources. This is particularly true if one considers the transistory phase where the substituting process has to exhibit a rapid exponential growth rate. The energetical effectiveness of the production of a synthetic fuel, as for example hydrogen by water splitting processes, is addressed at the end and serves to give an idea how effectively the energy available in fossil fuels can be amplified by virtue of the coupling of nuclear energy into the process.

FUEL CYCLE

REFER ALSO TO CITATION(S) 36920

PROCESS HEAT REACTORS

REFER ALSO TO CITATION(S) 37265

37354 Technology assessment on nuclear steelmaking. I. *Technocrat;* **8**: No. 5, 6-17(May 1975).

Pollution-free nuclear steelmaking using a high-temp, gas cooled reactor is expected to require a small construction cost and (if reducing agents and heat sources are available at a sufficiently low cost) a lower processing cost compared with the blast furnace. In developing countries a nuclear steelmaking plant proportional to the demand for steel could be a part of technological development assistance. Iron is reduced from ore containing FE 65-67% and gangue 4% in either a shaft-type or fluidized bed using reducing gas ($CO + H_2$) from crude oil, thus being completely independent of coal.

37355 Nuclear power for vehicular engines. Mathur, H.B. pp 171-184 of Total energy and energy substitution, seminar proceedings, New Delhi, March 28-30, 1973. New Delhi; National Productivity Council (1976).

From Seminar on total energy and energy substitution; New Delhi, India (28 Mar 1973).

See CONF-730389—.

The role of nuclear energy in vehicular engines is discussed. The concept of 'energy depots' for storing chemical energy converted from nuclear energy is explained. Such systems will be very useful for storing energy in chemical fuels which can later be utilized for powering vehicles. The two processes of energising chemical fuels from nuclear energy, namely, (1) the fuel manufacturing and (2) the fuel regeneration system, are described. The advantages of switching over to such energy depots is pointed out.

37356 (Juel—1413) Material development for gas-cooled high temperature reactors for the production of nuclear process heat. Nickel, H. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorwerkstoffe und Heisse Zellen). Apr 1977. 36p. (In German). Dep. NTIS (US Sales Only), PC A03/MF A01.

In the framework of the material development for gas-cooled high temperature reactors, considerable investigations of the materials for the reactor core and the primary circuit are being conducted. Concerning the core components, the current state-of-the-art and the objectives of the development work on the spherical fuel elements, coated particles and structural graphite are discussed. As an example of the structural graphite, the non-replaceable reflector of the process heat reactor is discussed. The primary circuit will be constructed mainly from metallic materials, although some ceramics are also being considered. Components of interest are hot gas ducts, liners, methane reformer tubes and helium-helium intermediate heat exchangers.

37357 CANDU reactor operation for electricity production and district heating. Rogers, J.T.; Abdelkerim, A.E.; Swinton, M.C. (Carleton Univ., Ottawa). *Nucl. Technol.;* **38**: No. 2, 165-173(Apr 1978).

From Conference on low-temperature nuclear heat; Ontaniemi, Finland (21 Aug 1977).

Taking advantage of the potential benefits of a combined electricity production and district heating nuclear power plant requires the integration of the plant into two grids: the electrical grid and the thermal grid. The integration of a CANDU reactor of the Pickering type into the grids has been assessed, and some preliminary conclusions have been reached. For a given system size and fractional nuclear capacity, the practical optimum extraction point for steam from the turbines for the district heating system has been established. With steam from the practical optimum extraction point, there is considerable economic incentive to maximize the fractional nuclear capacity of the system. As a system grows, the unit thermal costs of heat at the plant boundary are reduced significantly by adding nuclear capacity. This conclusion suggests that advantage be taken of the characteristic flexibility of extraction-condensing turbines to accelerate the growth of the nuclear contribution to the system.

37358 Atomic central heating-and-power plants and atomic boiler houses. Sokolov, I.N.; Skvortsov, S.A. (Inst. of Atomic Energy, Moscow). *Nucl. Technol.;* **38**: No. 2, 174-177(Apr 1978).

From Conference on low-temperature nuclear heat; Otaniemi, Finland (21 Aug 1977).

Nuclear steam generators can be used either to generate electricity and steam or only as steam generators without electricity production. The generation of steam alone leads to simplified construction practices that can save money without sacrificing safety requirements. However, the low usage factor of a steam-only system used for central heating decreases plant overall efficiency and increases capital costs relative to steam costs supplied along with electricity.

37359 Survey of existing district heating systems. Scholten, V. (Kraftwerk Union AG, Offenbach, Ger.); Timm, M. *Nucl. Technol.;* **38**: No. 2, 178-186(Apr 1978).

From Conference on low-temperature nuclear heat; Otaniemi, Finland (21 Aug 1977).

In the western world, there is a wide variance of distinct heating capacity, but it can be stated generally that those countries that developed systems early have a substantial lead in technology. Development in the eastern bloc is largely parallel to that of the west in that most work has been undertaken during the post-war period. World events have played their part, notably the oil crisis of 1973, which has led to more rational energy policies and usage, in addition to the consideration of alternative primary fuel sources. While this quest for other energy reserves continues, most countries are turning to indigenous fuels. This, of course, leads, wherever possible, to partial fuel independence, a state that is more pronounced in the eastern bloc. At present, the Federal Republic of Germany has the largest connected public system in the west, although in terms of megawatts per thousand inhabitants, Scandinavia comes out ahead. Obviously, information from eastern Europe is difficult to obtain, although it is known that substantial district heating systems are in existence in the bloc. As far as heat production is concerned, there are two systems: (1) dual-purpose, where a power station (nuclear or conventional) produces heat as by-product in the generation of electrical energy; and (2) heat-only, where the production of heat energy is the primary purpose. In terms of economic feasibility, a local nuclear power station could be more efficient than a conventional station, when dual-purpose stations are considered. Quite obviously, present and future usage and development depend on several important factors, including geographical location, influencing climate, local supply, and political considerations. At the present time, western development is limited mainly to preliminary studies and the consideration of one of the most important basic questions, that covering the role of nuclear energy in district heating systems.

37360 Economics of long-distance transmission, storage, and distribution of heat from nuclear plants with existing and newer techniques. Margen, P.H. (AB Atomenergi, Nykoeping, Sweden). *Nucl. Technol.;* **38**: No. 2, 192-203(Apr 1978).

From Conference on low-temperature nuclear heat; Otaniemi, Finland (21 Aug 1977).

Conventional and newer types of hot-water pipes are applied to the bulk transport of reject heat from central nuclear power plants to the district heating network of cities or groups of cities. With conventional pipes, the transport of 300 to 2000 MW of heat over distances of 30 to 100 km can be justified, while with newer pipe types, even longer distances would often be economic. For medium-size district heating schemes, low-temperature heat transport from simple heat-only reactors suitable for closer location to cities is of interest. For daily storage of heat on district heating systems, steel heat accumulators are currently used in Sweden. The development of more advanced cheaper heat accumulators, such as lake storage schemes, could make even seasonal heat storage economic. Newer distribution technology extends the economic field of penetration of

district heating even to suburban one-family house districts. With proper design and optimization, nuclear district heating can be competitive in a wide market and achieve very substantial fossil-fuel savings.

37361 HERA: a high-temperature reactor for use in a refinery. Chaubernard, P.H. (Compagnie Francaise de Raffinage, Paris); d'Ervau, G.L.; Pfertzel, R. *Nucl. Technol.;* **38**: No. 2, 204-208(Apr 1978).

From Conference on low-temperature nuclear heat; Otaniemi, Finland (21 Aug 1977).

Oil consumption in a refinery is approximately 6 percent of the production, which indicates a great interest in the use of nuclear heat to save oil. A high-temperature reactor (HTR) was designed to be used in an existing refinery in France having a crude oil throughput of 20 Tg/yr. The HTR produces only one part of the process heat, which is distributed by hot helium in a localized part of the refinery to decrease the length of helium ducts. The present boiler is kept in operation and is running at 30 percent capacity to have steam and electricity available in case of reactor shutdown. With a 1000 MW of thermal energy reactor, the amount of fuel conserved is 500 Gg/yr. The studies have shown that it was technically possible to use an HTR to provide a large part of the energy. However, economic calculations lead to a prime cost of conserved crude oil of almost twice the existing price. This situation could change if the cost of the crude oil increases significantly.

37362 Dual-purpose light water reactor supplying heat for desalination. Waplington, G.; Fichtner, H. (Electrowatt Engineering Services Ltd., London). *Nucl. Technol.;* **38**: No. 2, 215-220(Apr 1978).

From Conference on low-temperature nuclear heat; Otaniemi, Finland (21 Aug 1977).

The technical as well as the economic aspects of using a large commercial light water reactor for the production of both electricity and potable water have been examined. For the basis of the study, the multistage flash distillation process was selected, in conjunction with a reactor rated at not less than 2100 MW (thermal). Combined use of a condensing and a back-pressure turbine (the latter matched to distillation plant steam requirements) represents a convenient method for supplying process heat. Overall costs can be fairly allocated to the two products using the "power credit" method. A sample economic evaluation indicates highly favorable water costs as compared with more conventional distillation schemes based on fossil fuel.

37363 Boiling water reactor in a prestressed reinforced concrete vessel for an atomic central heating-and-power plant. Tokarev, Yu.I.; Sokolov, I.N.; Skvortsov, S.A.; Sidorov, A.M.; Krauze, L.V. (Inst. of Atomic Energy, Moscow). *Nucl. Technol.;* **38**: No. 2, 221-224(Apr 1978).

From Conference on low-temperature nuclear heat; Otaniemi, Finland (21 Aug 1977).

The possibility of using a boiling water reactor in a prestressed reinforced concrete vessel for an atomic central heating-and-power plant (CHPP) was considered, with design features of the reactor intended for a two-purpose plant. A prestressed reinforced concrete vessel and integral arrangement of the primary circuit ensured reliability of the atomic CHPP using various CHPP flowsheets.

37364 SECURE nuclear district heating plant. Nilsson (AB ASEA-ATOM, Vaesteras, Sweden); Hannus, M. *Nucl. Technol.;* **38**: No. 2, 225-234(Apr 1978).

From Conference on low-temperature nuclear heat; Otaniemi, Finland (21 Aug 1977).

The role foreseen for the SECURE (Safe Environmentally Clean Urban REactor) nuclear district heating plant is to provide the baseload heating needs of primarily the larger and medium size urban centers that are outside the range of waste heat supply from conventional nuclear power stations. The rationale of the SECURE concept is that the simplicity in design and the inherent safety advantages due to the use of low temperatures and pressures should make such reactors economically feasible in much smaller unit sizes than nuclear power reactors and should make their urban location possible. It is felt that the present design should be safe enough to make urban underground location possible without restriction according to any criteria based on actual risk evaluation. From the environmental point of view, this is a municipal heat supply plant with negligible pollution. Waste heat is negligible, gaseous radioactivity release is negligible, and there is no liquid radwaste release. Economic comparisons show that the SECURE plant is competitive with current fossil-fueled alternatives. Expected future increase in energy raw material prices will lead to additional energy cost advantages to the SECURE plant.

37365 Application of the integrated pressurized water reactor to district heating and desalination. Boese, F.K.; Kadella, H. (INTERATOM, Gladbach, Ger.). *Nucl. Technol.;* **38**: No. 2, 235-241(Apr 1978).

From Conference on low-temperature nuclear heat; Otaniemi, Finland (21 Aug 1977).

Oil prices have been rising significantly in recent years. The result is a steady lowering of the economic break-even point of nuclear power plants. Already, our actual oil price level allows nuclear dual-purpose plants to become efficient below a thermal power of 800 MW. Two special applications of an Integrated Pressurized Water Reactor System use the waste heat of the turbine for district heating or water desalination. An integrated system of heat pump and nuclear heat source avoids the usual transportation losses from the power plant to the compressor of the heat pumps.

37366 Thermos reactors. Labrousse, M. (Technicatome, Gif-sur-Yvette, France); Lerouge, B.; Dupuy, G.; Schwartz, J.P. *Nucl. Technol.;* **38**: No. 2, 242-247(Apr 1978).

From Conference on low-temperature nuclear heat; Otaniemi, Finland (21 Aug 1977).

THERMOS is a water reactor designed to provide hot water up to 120°C for district heating or for desalination applications. It is a 100-MW reactor based on proven technology: oxide fuel plate elements, integrated primary circuit, and reactor vessel located in the bottom of a pool. As in swimming pool reactors, the pool is used for biological shielding, emergency core cooling, and fission product filtering (in case of an accident). Before economics, safety is the main characteristic of the concept: no fuel failure admitted, core under water in any accidental configuration, inspection of every "nuclear" component, and double-wall containment.

37367 Nuclear-powered agro-industrial complexes for optimum energy utilisation. Sunder Rajan, N.S.; Ramani, M.P.S.; Thomas, K.T. pp 269-282 of Total energy and energy substitution, seminar proceedings, New Delhi, March 28-30, 1973. New Delhi; National Productivity Council (1976).

From Seminar on total energy and energy substitution; New Delhi, India (28 Mar 1973).

See CONF-730389—.

The concepts of the nuclear agro-industrial complex exemplifies the total energy approach as applied to nuclear power production and utilization. In a dual purpose nuclear power station, desalination of sea water offers exploitation of marine chemicals in addition to providing a new source of water. Also, power intensive fertilizer units could be put up adjascent to the power station for utilization of power at low transmission costs. Two projects envisaged in India based on this concept, i.e. the Western U.P. Project and the Kutch Saurashtra Project are described in detail. The capital investments, annual expenses and profits presented. The validity of these plans are discussed.

37368 Technology assessment on nuclear steelmaking. II. *Technocrat;* **8**: No. 6, 21-31(Jun 1975).

A nuclear unit which is a combined type of a gas-cooled reactor capable of producing high-temp. energy (1000°C or higher) and a light-water type power reactor, can supply economical heat, electricity, process steam and fresh water for the Fe industry or the like where there is a demand for such energy. Although a comparison of nuclear and conventional steelmaking shows that the nuclear system has many economic advantages, the direct and secondary influences of radio-activity indicate that considerable development investment will be required in this area.

NUCLEAR REACTOR TECHNOLOGY

37369 Structural mechanics in reactor technology. Vol. B. Thermal and fluid/structure dynamics analysis. Jaeger, T.A.; Boley, B.A. (eds.). Brussels; Commission of the European Communities (1977). 311p. (CONF-770807—Pt.B).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

This volume covers thermal and fluid/structure dynamics analysis in reactor technology. Separate abstracts have been prepared for each of the individual papers included.

37370 Structural mechanics in reactor technolgy. Vol. M. Methods for structural analysis. Jaeger, T.A.; Boley, B.A. (eds.). Brussels; Commission of the European Communities (1977). 444p. (CONF-770807—Pt.M).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

This volume covers sessions on methods for structural analysis. Separate abstracts were prepared for each of the individual papers included.

37371 Structural mechanics in reactor technology. Vol. L. Inelastic analysis of metal structures. Jaeger, T.A.; Boley, B.A. (eds.). Brussels; Commission of the European Communities (1977). 662p. (CONF-770807—Pt.L).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

This volume covers sessions on inelastic analysis of metal structures. Separate abstracts were prepared for each of the individual papers included.

THEORY AND CALCULATION

REFER ALSO TO CITATION(S) 38551, 38723

37372 (ECN—27) Integral determination of fission product neutron capture cross sections for application in fast reactors. Bustraan, M.; Dekker, J.W.M.; Heijboer, R.J.; Janssen, A.J. (Stichting Energieonderzoek Centrum Nederland, Petten). Sep 1977. 56p. (CONF-7709105—2). Dep. NTIS (US Sales Only), PC A04/MF A01.

From Meeting on fission product nuclear data; Petten, Netherlands (5 Sep 1977).

Integral measurements of fission product capture cross-sections in fast reactors performed and analysed up to now are reviewed. A comparison is made with calculated integral data using various fission product cross-section evaluations. This is done for individual nuclides as well as for gross mixtures of fission products.

37373 Prediction of burnout. Chapter 14. Lee, D.H. (UKAEA Reactor Group, Winfrith. Atomic Energy Establishment). pp 295-322 of Two-phase flow and heat transfer. Butterworth, D.; Hewitt, G.F. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment) (eds.). Oxford; University Press (1977).

A broad survey is made of the effect on burnout heat flux of various system parameters to give the reader a better initial idea of the significance of changes in individual parameters. A detailed survey is then made of various correlation equations for predicting burnout for steam -water in uniformly heated tubes, annuli, rectangular channels and rod clusters, giving details of recommended equations. Finally comments are made on the influence of heat-flux profile and swirl flow on burnout, and on the definition of dryout margin.

37374 (FEI—658) Problem of noise spectra classification in nuclear power plant operation diagnostics. Mogil'ner, A.I.; Krivelev, G.P.; Skomorokhov, A.O.; Shvetsov, D.M. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk. Fiziko-Ehnergeticheskij Inst.). 1976. 18p. (In Russian). Dep. NTIS (US Sales Only), PC A02/MF A01.

A problem of classifying noise spectra in the diagnostics of nuclear power plants is described. A formalized method is given for separating the characteristic frequencies (informative signs) of the spectra. The effectiveness of the method has been tested by solving a problem of identifying the boiling of a certain form by the appearance of the acoustic spectrum.

37375 (IAE—2549) Variational method of calculation of kinetic equations in periodic lattices. Plyashkevich, V.Yu. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1975. 29p. (In Russian). Dep. NTIS (US Sales Only), PC A03/MF A01.

A variational method is described for solving the problem on neutron transport in periodic nonreproducing lattices in the one-velocity kinetic approximation with an allowance for anisotropy in scattering and in the neutron source. The authors consider questions of convergence and stability of the method. They give estimates of the error in the approximate solution of the problem.

37376 (INDC(CCP)—109/U) Adjustment of evaluated microscopic data on the basis of evaluated integral experiments. Usachev, L.N.; Kazanskii, Yu.A.; Dulin, V.A.; Bobkov, Yu.G. (International Atomic Energy Agency, Vienna (Austria). International Nuclear Data Committee). Aug 1977. 6p. Dep. NTIS (US Sales Only), PC A02/MF A01.

Translated from Russian.

A new set of 78 integral experiments is described and used for the adjustment of constants. The adjustments are not very great in relation to the optimized system of constants for OSCAR-75 atomic reactors, which was described two years ago.

37377 (ITEF—19) Numerical calculation of fuel burn-up in a reactor. Afanas'ev, A.M.; Torlin, B.Z. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1976. 32p. (In Russian). Dep. NTIS (US Sales Only), PC A03/MF A01.

A procedure is described for a numerical solution of a nonlinear problem of calculating the reactor height field taking into account a deep fuel depletion, coolant boiling and other effects. The method is based on the iteration process of direct "rundown" of a nonlinear problem solution. The stability of the process has been investigated. As a result of the analysis techniques have been found which have accelerated substantially the convergence of the iteration process.

37378 Matching of dense plasma focus devices with fission reactors. Harms, A.A.; Heindler, M. (McMaster Univ., Hamilton, Ont.). *Nucl. Sci. Eng.;* **66**: No. 1, 1-8(Apr 1978).

The potential role of dense plasma focus devices as compact neutron sources for fissile fuel breeding in conjunction with existing fission reactors is considered. It is found that advanced plasma focus devices can be used effectively in conjunction with neutronically efficient fission reactors to constitute "self-sufficient" breeders. Correlations among the various parameters such as the power output and conversion ratio of the fission reactor with the neutron yield and capacitor bank energy of the dense plasma focus device are presented and discussed.

37379 Monte Carlo perturbation source method for reactivity calculations. Hoffman, T.J.; Petrie, L.M.; Landers, N.F. (Oak Ridge National Lab., TN). *Nucl. Sci. Eng.;* **66**: No. 1, 60-66(Apr 1978).

A Monte Carlo method for the calculation of the change in the neutron multiplication factor of a reactor due to cross-section perturbations is developed. Although similar to the perturbation source method developed by Matthes, this method is not limited to problems in which first-order perturbation theory is applicable. This method has been implemented in the KENO computer code and applied to a variety of problems. The results of these calculations are presented. This approach should prove useful in the solution of problems in which other Monte Carlo methods, such as Matthes' first-order perturbation source method and correlated sampling, fail.

37380 Finite element analysis for turbulent flows of incompressible fluids in fuel rod bundles. Slagter, W. (Netherlands Energy Research Foundation (ECN), Petten). *Nucl. Sci. Eng.;* **66**: No. 1, 84-92(Apr 1978).

The paper deals with the application of the finite element method to solve the momentum equation for the central subchannel of a fuel rod bundle. The Galerkin procedure in the method of weighted residuals is used to form the nonlinear algebraic equations that are solved by means of the Newton-Raphson approach. For turbulent flow, the eddy diffusivities are determined by Prandtl's mixing length hypothesis. The mixing lengths perpendicular and parallel to the wall are calculated from geometrical conditions using relations obtained by various authors. The results obtained are critically compared with experimental data and also with those obtained by finite difference procedures. There is a close agreement between the finite element results and other calculated data. Corresponding results also show a good agreement with experimental data.

37381 Characteristics, stability, and short-wavelength phenomena in two-phase flow equation systems. Ramshaw, J.D.; Trapp, J.A. (Aerojet Nuclear Co., Idaho Falls, ID). *Nucl. Sci. Eng.;* **66**: No. 1, 93-102(Apr 1978).

The occurrence and significance of complex characteristics in two-phase flow equation systems are clarified by a detailed analysis of separated two-phase flow between two parallel plates. The basic system of one-dimensional two-phase flow equations for this problem possesses complex characteristics, exhibits unbounded instabilities in the short-wavelength limit, and constitutes an improperly posed initial value problem. These difficulties have led some workers to propose major modifications to the basic equation system. We show that the relatively minor modification of introducing surface tension is sufficient to render the characteristics real, stabilize short-wavelength disturbances, and produce a properly posed problem. For a given value of the surface tension, the basic equation system thus modified is shown to correctly predict the evolution of small-amplitude disturbances having wavelengths long compared to the plate spacing. A formula is given for the artificial surface tension necessary to stabilize wavelengths on the order of the mesh spacing in a finite difference numerical calculation. A brief discussion is given concerning the expected behavior of surface tension as compared to viscosity in the nonlinear regime. The general relation between characteristics and stability is discussed in an appendix.

37382 Applications of the upper bound estimation method in reactor theory. Ronen, Y.; Regev, D. (Ben-Gurion Univ. of the Negev, Beersheva, Israel). *Nucl. Sci. Eng.;* **66**: No. 1, 124-127(Apr 1978).

The upper bound estimation method is applied for estimating perturbations in reactor theory calculations. The results of this method are numerically compared with the regular first-order perturbation theory. It is concluded from the comparison that first-

order perturbation in the integral formalism gives the best estimate for the changes in eigenvalues. For those cases in which first-order perturbation yields low estimates, it is possible to obtain lower and upper bounds by applying both methods. A discussion of the possibility of obtaining a rough estimation to a perturbation without knowing the unperturbed regular and adjoint fluxes is presented and demonstrated with a numerical example.

37383 Modeling the effect of fission product capture on reactor decay power. Spinrad, B.I.; Tripathi, A. (Oregon State Univ., Corvallis). *Nucl. Sci. Eng.;* **66**: No. 1, 140-141(Apr 1978).

Analytical formalisms modeling the effect of fission product capture on decay power are collected, and one simple model is recommended. The model is valid for long operating times and shutdown times less than 10^4 s.

37384 Introduction to burnout. Chapter 12. Shires, G.L. (UKAEA Reactor Group, Winfrith. Atomic Energy Establishment). pp 252-278 of Two-phase flow and heat transfer. Butterworth, D.; Hewitt, G.F. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment) (eds.). Oxford; University Press (1977).

The evaluation of burnout in industrial plant involves combination of analysis of existing data, theoretical models, and detailed experimental investigation using electrical heating. Progress is being made towards better understanding of the mechanisms of burnout, and data are being accumulated from experiments with straight tubes, bends, and coils covering a wide range of pressures. The synthesis of experimental data and theoretical models may in the future provide methods of predicting burnout, even in complex geometries, but it is unlikely that this will supersede the need for full-scale confirmatory testing of specific designs when high accuracy of prediction is required.

COMPONENTS AND ACCESSORIES

REFER ALSO TO CITATION(S) 37452, 37464

37385 (KFK—2435, pp 484-487) **Decontamination of big components.** Hentschel, D. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Abt. zur Behandlung Radioaktiver Abfaelle). Apr 1977. (In German).

In Second semiannual report 1976.

Experiments have been started with currently used decontamination chemicals to find the optimum working conditions with respect to working temperatures, concentrations and liquid decontamination waste generation. A dipping technique was used for application of the chemicals to the contaminated stainless steel samples. Up to now have been tested: nitric acid, nitric-hydrofluoric acid mixture, alkaline potassium permanganate, oxalic acid and oxalic-citric acid mixture. The experiments carried out up to now, show the following results. a) All chemicals are more efficient at 80°C working temperatures than at room temperature. b) 4 m nitric acid is an optimum with respect to decontamination efficiency and waste generation. c) The concentration of 3% HF/20% HNO_3 mixture can be reduced to 1,5% HF/10% HNO_3 without reduction of cleansing efficiency. d) The same reduction is possible for alkaline $KMnO_4$ solution. The decontamination efficiency for Ru-106 is excellent. e) Oxalic acid in a concentration of 1% is an optimum. f) Best decontamination results gives a mixture of 0.2 m citric acid plus 0.3 m oxalic acid.

37386 (KURRI-TR—148) **In-place tests of exhaust equipment in nuclear facility.** Yokochi, A.; Yamazaki, K.; Tsujimoto, T.; Tsutsui, T.; Katsurayama, K. (Kyoto Univ., Kumatori, Osaka (Japan). Research Reactor Inst.). 6 Nov 1976. 15p. (In Japanese). Dep. NTIS (US Sales Only), PC A02/MF A01.

The in-place tests are performed using DOP aerosols about the exhaust equipment of Research Reactor Institute, Kyoto University. As a result, we found a problem about the support of high efficiency particulate air filter was discovered. The filter frame in the chamber of exhaust equipment was improved. This paper is the summary of the results about the in-place tests and the improvements, the amount of dust load and radioactivity, and a consideration about a cycle of the exchange of filters, and an in-place test method.

37387 (MRR—169) **Simulation experiments concerning functioning tests of technical safety devices with process computers. Pt. 2. Results of simulation experiments with a new concept for computerized inspection techniques.** Hawickhorst, W. (Technische Univ. Muenchen, Garching (Germany, F.R.). Lab. fuer Reaktorregelung und Anlagensicherung). Dec 1976. 185p. (In German). Dep. NTIS (US Sales Only), PC A09/MF A01.

Computerized inspection techniques of engineered safety systems improve the diagnosis capability, relative to the presently used techniques, even if anticipated system disturbances can only be qualitatively predicted. To achieve this, the system to be inspected must be partitioned into small subsystems, which can be treated independently from each other. This report contains the formulation of a standardized inspection concept based on system decomposition. Its performance is discussed by means of simulation experiments.

37388 Method and apparatus for locating deflective fuel rods of a reactor fuel element. Jester, A.; Heidtmann, U.; Birnbreier, H. (to Babcock-Brown Boveri Reaktor GmbH). US Patent 4,079,620. 21 Mar 1978. Priority date 11 Feb 1975, German, Federal Republic of (F.R. Germany). 8p.

A method and apparatus for locating defective fuel rods of a liquid cooled reactor core wherein the rods have end caps and defective rods collect leakage liquid from the core in the end caps, includes heating the end caps of a plurality of rods to evaporate the leakage liquid, measuring the temperatures of the end caps of the plurality of rods, and simultaneously indicating the temperature differences between defective and non-defective rods. The rods are supported in a container filled with a liquid and the upper ends of the rods and end caps are enclosed within the container in a dry heated temperature. The apparatus includes means for heating the end caps, means for measuring the temperatures and means for simultaneously indicating the temperatures and temperature differences.

37389 Ball check valve. Bevilacqua, F. (to Combustion Engineering, Inc.). US Patent 4,070,239. 24 Jan 1978. Filed date 23 Apr 1976. 6p.

A pressurized nuclear reactor having an instrument assembly sheathed in a metallic tube which is extended vertically upward into the reactor core by traversing a metallic guide tube which is welded to the wall of the vessel is described. Sensors in each instrument assembly are connected to instruments outside the vessel to manifest the conditions within the core. Each instrument assembly probe is moved into position within a metallic guide channel. The guide channel penetrates the wall of the vessel and forms part of the barrier to the environment within the pressure vessel. Each channel includes a ball check valve which is opened by the instrument assembly probe when the probe passes through the valve. A ball valve element is moved from its seat by the probe to a position lateral of the bore of the channel and is guided to its seat along a sloped path within the valve body when the probe is removed. 5 claims, 3 figures.

37390 Corrosion product stability in high temperature aqueous systems - deuterium isotope effects. Tremaine, P.R.; Rummery, T.E.; von Massow, R. (Atomic Energy of Canada Ltd., Pinawa, Manitoba. Whiteshell Nuclear Research Establishment). *J. Nucl. Mater.;* **68**: No. 3, 351-354(Nov 1977).

The authors deduce the D_2/D_2O mole fraction required to stabilize desirable corrosion products in D_2O systems. The work is done with reference to reactor coolant systems.

37391 Summary of the fifth international conference on reactor shielding. Roussin, R.W.; Abbott, L.S.; Bartine, D.E. (Oak Ridge National Lab., Tenn. (USA)). *Atomkernenergie;* **30**: No. 4, 227-228(1977).

From 5. international reactor shielding conference; Knoxville, Tenn. (18 - 22 Apr 1977).

The Fifth International Conference on Reactor Shielding was held April 18-23, 1977 in Knoxville, Tennessee. The meeting was the largest in the series and attracted participants from 34 countries. The 10 invited papers and 10 of the contributed papers, selected as being representative of the Conference by the Technical Program Committee, are published in this issue of ATOMKERNENERGIE. This collection of papers demonstrates that the field of nuclear reactor shielding has developed into a mature discipline while retaining a definite vitality.

37392 Structural mechanics in reactor technology. Vol. F. Structural analysis of reactor core and coolant circuit structures. Jaeger, T.A.; Boley, B.A. (eds.). Brussels; Commission of the European Communities (1977). 563p. (CONF-770807—Pt.F).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

This volume covers sessions on structural analysis of reactor core and coolant circuit structures. Separate abstracts were prepared for each of the individual papers included.

37393 Structural mechanics in reactor technology. Vol. H. Structural engineering of prestressed reactor pressure vessels. Jaeger, T.A.; Boley, B.A. (eds.). Brussels; Commission of the European Communities (1977). 456p. (CONF-770807—Pt.H).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

This volume covers sessions on structural engineering of prestressed reactor pressure vessels. Separate abstracts were prepared for each of the individual papers included.

37394 Structural mechanics in reactor technology. Vol. G. Structural analysis of steel reactor pressure vessels. Jaeger, T.A.; Boley, B.A. (eds.). Brussels; Commission of the European Communities (1977). 616p. (CONF-770807—Pt.G).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

This volume covers sessions on structural analysis of steel reactor pressure vessels. Separate abstracts were prepared for each of the individual papers included.

37395 Nuclear reactor. Johnson, J.E. (to Westinghouse Electric Corp., Pittsburgh, Pa. (USA)). German(FRG) Patent 255,7332/A/. 8 Jul 1976. 29p. (In German).

9 figs.

In order to protect a nuclear reactor efficiently also when the fuel elements begin to melt, it is proposed instead of the core catcher provided for this case, to arrange a larger number of smaller collecting vessels, each below a fuel element, intended to catch melted particles, to cool them well, and if necessary, to discharge them. The containers are made of high-temperature resistant material (stainless steel, ceramics).

37396 Method and composition for removing iodine from gases. Goldsmith, J.M.; O'Hara, D.K.; Rivers, R.D.; Pasha, M.; Fowler, E.E. Australian Patent 75/79900/A/. 7 Apr 1975. Priority date 18 Jul 1974, United States of America (USA). 16p.

A radioactive iodine-iodide absorbing material is described, comprising a ceramic material impregnated with a metallic salt. A method for the manufacture of the ceramic and a method for the removal of radioactive iodine and organic iodides from off-gas streams from nuclear reactors are also described.

FUEL ELEMENTS

37397 (ANL—77-85) Radiographic inspection and densitometric evaluation of CP-5 reactor fuel. Staroba, J.F.; Knoerzer, T.W. (Argonne National Lab., Ill. (USA)). Feb 1978. Contract W-31-109-ENG-38. 30p. Dep. NTIS, PC A03/MF A01.

This report covers the radiographic and densitometric techniques used as part of a quality verification program for CP-5 reactor fuel by the Nondestructive Assay Section of the Special Materials Division. Other nondestructive tests used were ultrasonic and gamma-ray spectrometry. The main objectives were to perform a one-hundred percent radiographic inspection of the fuel tubes and to derive a quantitative relationship between fuel thickness and film density with the use of fabricated fuel step wedges. By the use of tangential x-ray techniques, measurements were made of fuel peaks or "hot spots" that protruded above the main fuel line. Other general problems in radiographic inspection and solutions for the upgrading of the total radiographic inspection program are also discussed.

37398 Nuclear reactor spring strip grid spacer. Patterson, J.F.; Flora, B.S. (to Exxon Nuclear Co., Inc.). US Patent 4,077,843. 7 Mar 1978. Filed date 21 May 1976. 8p.

A bimetallic grid spacer is described comprising a grid structure of zircaloy formed by intersecting striplike members which define fuel element openings for receiving fuel elements and spring strips made of Inconel positioned within the grid structure for cooperating with the fuel elements to maintain them in their desired position. A plurality of these spring strips extend longitudinally between sides of the grid structure, being locked in position by the grid retaining strips. The fuel rods, which are disposed in the fuel openings formed in the grid structure, are positioned by means of the springs associated with the spring strips and a plurality of dimples which extend from the zircaloy grid structure into the openings. In one embodiment the strips are disposed in a plurality of arrays with those spring strip arrays situated in opposing diagonal quadrants of the grid structure extending in the same direction and adjacent spring strip arrays in each half of the spacer extending in relatively perpendicular directions. Other variations of the spring strip arrangements for a particular fuel design are disclosed herein.

37399 Process and apparatus for sealing nuclear reactor fuel. Duncan, R.; Barna, R.P. (to Westinghouse Electric Corp.). US Patent 4,075,454. 21 Feb 1978. Filed date 10 Sep 1975. 6p.

A process and apparatus for simultaneously pressurizing a fuel rod having a plug in one end, welding a plug in the other end and sealing a gas pressurizing orifice therein in a single operation is described. A weld chamber is provided which accommodates one end of a seal rod having a plug fixed in the rod end by a friction fit. A mechanism pushes the fuel rod into the weld chamber which is then pressurized to force gas through a plug orifice into the fuel rod. During subsequent rotation of the rod, an electrode in the weld chamber forms a weld puddle which bridges the end plug-fuel rod interface and the plug orifice to thereby weld the plug in the rod and seal the plug orifice in a single operation. 6 claims, 3 figures.

37400 Device to accept axial forces occurring on fuel assemblies during the operation of nuclear reactors. Sankovich, M.F. (to Babcock and Wilcox Co.). US Patent 4,072,562. 7 Feb 1978. Priority date 25 Sep 1975, German, Federal Republic of (F.R. Germany). 4p.

The invention pertains to a device for accepting axial forces generated during the operation of a nuclear reactor by the flow of the cooling medium and the thermal expansion of the fuel assemblies consisting of rod-shaped fuel rods while the fuel assemblies are resting on a lower grid plate and at the upper end are elastically supported against an upper grid plate. 3 claims, 11 figures.

37401 Seal containment system. Kugler, R.W.; Gerkey, K.S.; Kasner, W.H. (to Westinghouse Electric Corp.). US Patent 4,070,240. 24 Jan 1978. Filed date 2 Feb 1977. 8p.

An automated system for transporting nuclear fuel elements between fuel element assembly stations without contaminating the area outside the sealed assembly stations is described. The system comprises a plurality of assembly stations connected together by an elongated horizontal sealing mechanism and an automatic transport mechanism for transporting a nuclear fuel element in a horizontal attitude between the assembly stations while the open end of the fuel element extends through the sealing mechanism into the assembly station enclosure. The sealing mechanism allows the fuel element to be advanced by the transport mechanism while limiting the escape of radioactive particles from within the assembly station enclosure. 4 claims, 6 figures.

37402 Fuel transfer machine. Bernstein, I. (to Combustion Engineering, Inc.). US Patent 4,069,766. 24 Jan 1978. Filed date 28 Nov 1975. 6p.

A nuclear fuel transfer machine for transferring fuel assemblies through the fuel transfer tube of a nuclear power generating plant containment structure is described. A conventional reversible drive cable is attached to the fuel transfer carriage to drive it horizontally through the tube. A shuttle carrying a sheave at each end is arranged in parallel with the carriage to also travel into the tube. The cable cooperating with the sheaves permit driving a relatively short fuel transfer carriage a large distance without manually installing sheaves or drive apparatus in the tunnel. 8 claims, 3 figures.

37403 Structural mechanics in reactor technology. Vol. C. Structural analysis of reactor fuel and cladding. Jaeger, T.A.; Boley, B.A. (eds.). Brussels; Commission of the European Communities (1977). 375p. (CONF-770807—Pt.C).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

This volume covers the sessions on structural analysis of reactor fuel and cladding. Separate abstracts were prepared for each of the individual papers included.

37404 Structural mechanics in reactor technology. Vol. D. Structural analysis of reactor fuel elements. Jaeger, T.A.; Boley, B.A. (eds.). Brussels; Commission of the European Communities (1977). 507p. (CONF-770807—Pt.D).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

This volume covers sessions on structural analysis of reactor fuel elements. Separate abstracts were prepared for each of the individual papers included.

CONTROL SYSTEMS

37405 Digital model helps review of nuclear power plant control system. Prabhakar, B.S.; Krishnamurthy, N. (Department of Atomic Energy, Bombay (India). Physics Committee); Kharche, P.G.; Shah, S.K. (Tata Consulting Engineers, Bombay (India)). pp 35-46 of Proceedings of the symposium on power plant dynamics and control [held at Bombay during] February 23-24, 1976. Bombay; Department of Atomic Energy (1976).

From Symposium on power plant dynamics and control; Bombay, India (23 Feb 1976).

See CONF-760265—.

Control philosophy for a generating unit of a particular size is influenced to a large extent by the capacity of the power system in which it operates. A large size unit operating in a small capacity grid presents special problems of control, as line disturbances and load fluctuations reflect directly on the unit. The control system has to be specially designed to take care of such transients for stable plant operation. In this context, the control aspects of the 200 MW Unit of Rajasthan Atomic Power Station were analysed and suitable changes in the control system proposed. Plant trip situations resulting from the power system disturbance during station operation were identified and simulated using the digital model.

37406 Apparatus for automatically starting up nuclear reactor. Omori, T.; Sugiyama, S. (to Hitachi, Ltd.). US Patent 4,077,836. 7 Mar 1978. Priority date 20 Sep 1974, Japan. 16p.

An apparatus is described for automatically starting up a nuclear reactor, which causes control rods in the reactor to be withdrawn in the predetermined order according to the signal obtained by adding the heat-up ratio as a compensatory component determined by the reactor pressure to the deviation of the heat-up ratio of the reactor temperature from the predetermined heat-up ratio and which causes the reactor to be subjected to heat-up and pressurization by opening turbine bypass valves when the heat-up ratio exceeds a reference value.

37407 Top closure for control rod drive for nuclear reactor. Raas, J.H.; Schwartz, J.I. (to Diamond Power Specialty Corp.). US Patent 4,076,144. 28 Feb 1978. Filed date 3 Jun 1976. 4p.

A removable top closure and venting assembly for the tubular housing of a control rod drive includes a mounting ring threadably inserted in the upper end of the housing, a fluid-sealing closure member beneath the mounting ring and which is mounted in and coupled to the mounting ring by means of a ball and socket joint, a gas vent defined by interconnecting passages extending through the closure and through the ball and socket joint, and a vent valve accessible from the top of the closure assembly. 3 claims, 2 figures.

37408 Control for nuclear reactor. Ash, E.B.; Bernath, L.; Facha, J.V. (to Rockwell International Corp.). US Patent 4,076,583. 28 Feb 1978. Filed date 4 Oct 1976. 10p.

A nuclear reactor is described having an inherently safe automatic shutdown capability comprising a pressure vessel, a core located within the vessel and containing a sufficient amount of fissionable material to establish and sustain a chain-type fission reaction, and a plurality of elongated conduits disposed in a regular arrangement within the vessel. Each of the conduits defines a fluid flow path and comprises a first section located within and extending through the core, and a second section located exteriorly of the core and positioned above the first section. Each of the conduits contains a plurality of substantially spherical bodies in a sufficient quantity to substantially fill the first section of each of the conduits. The conduits are provided with a first fluid connection to a lower part of the first section and a second fluid connection to an upper part of the second section for the passage of a pressurized fluid therethrough while maintaining the reactor in operation. The nuclear reactor further comprises a means for supplying the pressurized fluid to said first fluid connection for moving all of said plurality of bodies from said first section to said second section of each of the elongated conduits to form a hydraulically stacked bed of the spherical bodies. A bypass means is located intermediate the second fluid connection, and the second section of each of the conduits and includes a plurality of fluid passageways distributed along the length of the second section for permitting a portion of the pressurized fluid to bypass a portion of the stacked bed of bodies during normal operation of the reactor. 5 claims, 7 figures.

37409 Reactor power reduction system and method. Bruno, S.J.; Dunn, S.A.; Raber, M. (to Combustion Engineering, Inc.). US Patent 4,075,059. 21 Feb 1978. Filed date 28 Apr 1976. 20p.

A method of operating a nuclear power reactor is disclosed which enables an accelerated power reduction of the reactor without completely shutting the reactor down. The method includes monitoring the incidents which, upon their occurrence, would require an accelerated power reduction in order to maintain the reactor in a safe operation mode; calculating the power reduction required on the occurrence of such an incident; determining a control rod insertion sequence for the normal operation of the reactor, said sequence being chosen to optimize reactor power capability; selecting the number of control rods necessary to respond to the accelerated power reduction demand, said selection being made according to a priority determined by said control rod insertion sequence; and inserting said selected control rods into the reactor core. 11 claims, 13 figures.

37410 Survey, without the commotion of an accident situation. ENERGIE interview with Dr. Josef Vogl, President of the Landesamt fuer Umweltschutz in Bavaria, over the central supervision of nuclear power plants in Bavaria. Vogl, J. (Bayerisches Landesamt fuer Umweltschutz, Muenchen (Germany, F.R.)). *Energie;* **29**: No. 1, 1-4(Jan 1977). (In German).

2 figs.; 3 tabs.

Purpose and set-up of the system for the remote monitoring of facilities and vicinities are briefly described.

37411 Design of proportional-integral-derivative type optimal controller for a nuclear reactor. Pal, J. (Roorkee Univ. (India). Dept. of Electrical Engineering). pp 237-253 of Proceedings of the symposium on power plant dynamics and control. Bombay; Department of Atomic Energy (1976).

From Symposium on power plant dynamics and control; Bombay, India (23 Feb 1976).

See CONF-760265—.

A theoretic approach to the design of a proportional integral derivative (PID) type optimal controller for a nuclear reactor is considered. A linearized version of the state-space model of a nuclear-reactor-plant is investigated which shows very 'sluggish' response (settling time of the order of 600 seconds) to changes in the power demand and frequency. It is shown that with a judicious choice of state variables a PID type optimal controller realisation is possible. A controller is designed to minimise the effects of (a) a sudden increase or decrease in the electrical power demand (b) change in frequency at grid.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 37953, 38002, 38038

37412 Report to the New Zealand Government of the Fact Finding Group on Nuclear Power. Burns, M.; Askin, F.R.; Anstice, S.R.; Collins, E.R.; Corbet, P.S.; Downes, H.E.P.; Stewart, R.D.H. Wellington, New Zealand; Government Printer, Wellington, New Zealand (Mar 1977). 398p.

The Fact Finding Group was set up by the New Zealand government in late 1975 to enquire into and report on the possible environmental consequences of a nuclear power programme compared with possible alternatives. Its report deals with power supply demand and alternative sources for generation; nuclear physics, radiation and radiobiology; nuclear power generation and reactor safety; health risks; and the siting of power stations and their associated facilities.

37413 Incorporation of nuclear energy in power systems and its environmental impact. VII. Perina, F. pp 97-104 of Atomy slouzi cloveku. Vyuziti jaderne energie v praxi. Prague, Czechoslovakia; Prace (1976). (In Czech)

The scope of energy uses is quickly expanding and with it societyms dependence on energy. Four possible variants of energy supplies are presented which lend themselves to large-scale use, namely: nuclear fission, nuclear fusion, solar energy and geothermal energy. Nuclear power production is favourably affecting the world fuel situation. The questions of reliability and safety of nuclear equipment is discussed as well as its effect on environmental pollution, namely by waste heat.

SITING

37414 Nuclear power stations in mountains. *ERA (Foeren. Elektr. Ration. Anvaendning);* **50**: No. 10, 42, 47(1977). (In Swedish).

In September 1975 the Swedish government instructed the State Power Board (KVS) to investigate the question of the installation of nuclear power equipment in mountains. The investigation was to continue in depth the studies carried out earlier by the Central Operating Management (CDL) and reported in 1974 and 1975. The investigation was to clarify the advantages and disadvantages of the installation of nuclear power stations in mountains in comparison with equipment at ground level from the points of view of reactor safety, war-time protection and sabotage. The necessity for nuclear production in a war-time situation and shutting down of the nuclear equipment after completion of its service life was to be investigated also.

RADIOACTIVE EFFLUENTS

37415 (STH—1/77) **Radioactive emissions in the waste air from nuclear power stations in the year 1976.** Haubelt, R. (Bundesgesundheitsamt, Neuherberg (Germany, F.R.). Inst. fuer Strahlenhygiene). May 1977. 22p. (In German). Dep. NTIS (US Sales Only), PC A03/MF A01.

This is another part of the report on annual emissions of radioactive substances with the waste air from nuclear power stations in the FRG. Measurements were carried out by the Section for population protection against nuclear power plants of the Institut fuer Strahlenhygiene of the Bundesgesundheitsamt (Federal board of health) and documented in the STH reports. Apart from data on the nuclear power plants operated in the FRG up to 1976, data on US power plants up to the end of 1974 are given for comparison.

37416 (STH—2/76) **Compilation of data on the release of radioactive substances in the vent air of nuclear power plants in the Federal Republic of Germany in 1975.** Winkelmann, I.; Endrulat, H.J.; Haubelt, R.; Westpfahl, U. (Bundesgesundheitsamt, Neuherberg (Germany, F.R.). Inst. fuer Strahlenhygiene). Apr 1976. 80p. (In German). Dep. NTIS (US Sales Only), PC A05/MF A01.

The present compilation of data on the release of radioactive substances in the vent air of nuclear power plants in the FRG is a continuation of a report series on aerosol filter and iodine filter samples from the exhaust air control systems of the nuclear power plants Gundremmingen, Obrigheim, Wuergassen, Stade, Lingen and Biblis A. The reports have been issued by the Federal public health office since 1972. This report is supplemented by annual release values on radioactive noble gases, on short- and long-lived aerosols, and on gaseous ^{131}I, supplied by the individual nuclear power plants as in previous years on uniform questionnaires. Data on the release of tritium are also available from some nuclear power plants.

37417 Environmental aspects of nuclear power. Otsuka, Masuhiko (Electric Power Development Co. Ltd., Tokyo (Japan)). *Oyo Butsuri;* **46**: No. 4, 398-405(Apr 1977). (In Japanese).

Environmental problems pertaining to the nuclear power generation system are generally discussed based on a wide literature search and on the recent data of the release rate of radioactivity from operating nuclear power plants. This article is primarily written for those who are not so familiar to nuclear industry or hazards of radioactivity. The main sources of radioactivity in the nuclear power generation system, including uranium mining and spent fuel reprocessing are explained together with their relative significance to environmental pollution. The concept of man-rem and its probabilistic aspects are also explained by comparing with the intensity of radioactivity released from the nuclear industry with that of natural radioactivity. As for the release of radioactivity from the nuclear power plants, some measured data taken at individual operating LWR's in Japan are presented. Other items treated shortly in this report are: thermal pollution; differences in regulating philosophy from air pollutions due to other types of energy generation; significance of α-activity due to plutonium handling; and the final disposal of radioactive wastes.

CHEMICAL AND THERMAL EFFLUENTS

37418 (KFK—2435, pp 177-182) Environmental impact of cooling towers of large nuclear power plants. Nester, K. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Abt. Strahlenschutz und Sicherheit). Apr 1977. (In German).

In Second semiannual report 1976.

The results of computations performed for complex meteorological conditions have shown that the horizontal distributions of the relevant parameters normal to the direction of transport clearly differ from each other in the individual layers. The influence exerted by inversions gets particularly noticeable. Such structures cannot be treated by one-dimensional models. In some extreme cases the geometry of the visible plume completely differs from that which would be obtained with one-dimensional models. By use of the new model for the dispersion coefficients the distribution of the latter can be calculated also in a more realistic way than before. In case of overlapping of the plumes of several sources the restrictions imposed by the previous approach can be eliminated.

RESEARCH, TEST, AND EXPERIMENTAL REACTORS

37419 (AAEC/E—422) Measurement and calculation of slow power transients in the university training reactor, MOATA. Connolly, J.W.; McCulloch, D.B. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Sep 1977. 8p. Dep. NTIS (US Sales Only), PC A02/MF A01.

Self-limiting transients of initial period down to approximately 12 s have been measured in the AAEC's 100 kW Moata (University Training Reactor (UTR)) and the results compared with the predictions of a point-kinetics heat transfer model (ZAPP code). Although natural convection significantly affects the burst shape of such slow excusions, calculation and experiment are sufficiently in agreement to give confidence that the ZAPP model, which has been well tested against SPERT I data, can be successfully applied in safety studies for this class of reactor to predict the consequences of reactivity additions up to the onset of core melting.

37420 (AAEC-LIB/Trans—611) Experimental study of the behaviour of fission products following an accident on a swimming pool reactor. Dadillon, J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Nov 1976. 7p.p. Dep. NTIS (US Sales Only), PC A02/MF A01.

Translated from Bull. Inf. Sci. Tech. (France) (no.112) Feb 1967, p.13-18, bound with original.

In the estimation of nuclear risks connected with the running of a reactor an essential factor, sometimes neglected because insufficiently known, is the knowledge of the type, amount and behaviour of the contamination actually released inside the containment in the case of an accident. In the special case of swimming pool reactors the cooling fluid proves to be a very efficient barrier against contamination. Three experiments were carried out in the reactor CABRI, during which several fuel element plates were melted inside the core itself.

37421 (IWGFR—9, pp 81-87) Cavitation tests for a main circulation pump of JOYO primary circuit. Fukada, T.; Kamei, M.; Nishiguchi, Y.; Suzuki, A. Jun 1976.

From Specialist meeting on cavitation in sodium and studies of analogy with water as compared to sodium; Cadarache, France (12 Apr 1976).

In Specialists meeting on cavitation in sodium and studies of analogy with water as compared to sodium, Cadarache, France, April 12-16, 1976. Summary report.

A cavitation test was performed in sodium on the prototype of a main circulation pump of JOYO primary circuit and its results were compared with the data of the in-water test which had been performed on the same prototype.

37422 (JAERI-M—6845) First conceptual design of the experimental multi-purpose high-temperature gas-cooled reactor. Aochi, T.; Shimokawa, J.; Yasuno, T.; Yasukawa, S.; Mitake, S. (Japan Atomic Energy Research Inst., Tokyo). Jan 1977. 524p. (In Japanese). Dep. NTIS (US Sales Only), PC A24/MF A01.

Published in 2 parts.

First conceptual design of the Experimental Multipurpose High-temperature Gas-cooled Reactor was made to determine the plant systems including components and structures. Heat-and-mass balance in the cooling systems, operation modes of the plant, and the nuclear-thermal characteristics of the reactor core were first studied, and design conditions of the components and structures were specified. Then, structures of the reactor core and the cooling components such as intermediate heat exchanger steam generator, gas circulator, and coolant ducts were designed in detail, and also, control and protection systems, engineered safety systems, and plant buildings. Safety design criteria for the reactor plant, including definition of the plant conditions and safety classification of the components, were proposed.

37423 (JAERI-M—6893) Protective functions of the experimental multi-purpose high-temperature gas-cooled reactor. Ezaki, M.; Mitake, S.; Ishiguro, O.; Itoh, M.; Ozawa, T. (Japan Atomic Energy Research Inst., Tokyo). Jan 1977. 119p. (In Japanese). Dep. NTIS (US Sales Only), PC A07/MF A01.

Protective functions of the experimental multi-purpose high-temperature gas-cooled reactor being developed in JAERI were appraised in safety features of the operational protection system for events during normal operation at regular and frequent intervals and also the reactor protection system for unplanned events during abnormalities. Described are the plans of protection for the total plant system according to the current standards and criteria, setting of the actual safety systems in design safety limits, and protection sequences for normal operation occurences and unplanned abnormal events.

37424 (JAERI-M—6894) Study on core flow distribution of the reference core design Mark-III of experimental multi-purpose VHTR. Satoh, S.; Arai, T.; Miyamoto, Y.; Hirano, M. (Japan Atomic Energy Research Inst., Tokyo). Jan 1977. 60p. (In Japanese). Dep. NTIS (US Sales Only), PC A04/MF A01.

Concerning the coolant flow distribution between fuel channels and other flow paths in the core, designated as Reference Core Mark-III of the Multi-purpose Experimental Very High Temperature Reactor, thermal analysis has been made of the control rods and other steel structures around the core to find the coolant flow rates (bypass flow) necessary to cool them to their safe operating temperatures. Calculations showed that adequate cooling could be achieved in the Mark-III Core by the bypass flow of 8% of the total reactor coolant flow, 4% each for the control-rod channels and for other structures. The thermal and coolant flow design bases, including the assumption of a 10% bypass flow, were thus confirmed to first approximation.

37425 (JAERI-M—6895) Reference core design Mark-III of the experimental multi-purpose VHTR. Aochi, T.; Shimokawa, J.; Yasukawa, S.; Miyamoto, Y.; Shindo, R. (Japan Atomic Energy Research Inst., Tokyo). Dec 1976. 170p. (In Japanese). Dep. NTIS (US Sales Only), PC A09/MF A01.

The reference core design Mk-III of the experimental multi-purpose very high-temperature gas cooled reactor (thermal output 50MW with reactor outlet gas temperature 1000°C) is described, including design process and performance of the core. It provides the basis for core structure in the first conceptual design of the experimental multi-purpose VHTR. Covered in the Mark-III are design basis, design data, reactivity control system, core structure, fuel loading, control-rod withdrawal scheme, and core performance.

37426 (JAERI-M—6943) Characteristic measurements of JRR-2 after modification. (Japan Atomic Energy Research Inst., Tokyo).

Mar 1977. 169p. (In Japanese). Dep. NTIS (US Sales Only), PC A09/MF A01.

JRR-2 was shut down in December 1973, to improve it in heavy water leakage from the metal packing between core tank and support ring, corrosion of the lower shielding plug, and fault in the control-rod mechanism. Modification was on a standing seal to stop heavy water leakage at the support ring, replacement of the reactor top shield, replacement of the control-rod mechanism, improvement of the helium system, improvement of the irradiated air system to reduce radioactive argon gas release from the stack. Works were completed in September 1975. Functional tests and characteristic measurements then followed, to show good results of the modification.

37427 (JAERI-M—6945) **Analysis of fuel performance in core Mark-III of experimental multi-purpose very high temperature reactor.** Arai, T.; Ikushima, T.; Sato, S.; Suzuki, K.; Tani, Y. (Japan Atomic Energy Research Inst., Tokyo). Mar 1977. 101p. (In Japanese). Dep. NTIS (US Sales Only), PC A06/MF A01.

A reference core Mark-III has been designed for the first conceptual design of Experimental Multi-purpose Very High Temperature Reactor plant planned in JAERI. In this report are described comprehensive fuel performance analyses of the fuel integrity and fission product release in the core. Calculations, and comparisons with the design criteria have been made on chemical and mechanical behaviors including amoeba effect in the coated UO_2 particles, stresses in the coatings, fuel rods and graphite blocks, and release of metallic fission products.

37428 (JAERI-M—6974) **Reference design of the experimental multi-purpose high-temperature gas cooled reactor. Nuclear parametric lattice study in design of the fuel elements.** Shindo, R.; Hirano, M.; Aruga, T.; Yasukawa, S. (Japan Atomic Energy Research Inst., Tokyo). Mar 1977. 93p. (In Japanese). Dep. NTIS (US Sales Only), PC A05/MF A01.

The optimum dimensions of low-enriched uranium fuel rods in prismatic fuel elements are searched from the point of nuclear characteristics for both experimental (small scale) and commercial (large scale) multi-purpose high-temperature gas cooled reactor. Burnup characteristic of the low-enriched uranium fueled lattices depends strongly on the Nc/Nu (atomic number density ratio of carbon and uranium), sigma M (effective scattering cross section per resonance atom in fuel compact) and fuel enrichment (e).

37429 (PNC-N—941-76-18) **JOYO construction and preoperational test experience.** (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). Mar 1976. 38p. Dep. NTIS (US Sales Only), PC A03/MF A01.

The construction and installation of Joyo, the first experimental fast reactor in Japan, have been completed. The application for the license for Joyo was made with the output of 50 MW(t), and the power raising to 100 MW(t) target is left for future. Joyo is a sodium-cooled fast breeder reactor with mixed oxide fuel. The research and development for and the construction of Joyo are described. The initial stage of the preoperational test has been finished, and the further test stage is in progress. Sodium-cooled fast reactors are operated at higher temperature and lower pressure as compared with light water reactors, therefore the thermal stress is high, while the mechanical stress is low. The materials used for the sodium components are apt to creep, while the mechanical properties are impaired by the mass transfer in the hot sodium circuits. The guide lines for the structural design of Joyo were established on the basis of ASME Boiler and Pressure Vessel Code.

37430 (PTB-FMRB—65) **Report on work on the Forschungs- und Messreaktor Braunschweig (FMRB) for the year 1976.** Kriks, H.J.; Vorbrugg, W. (Physikalisch-Technische Bundesanstalt, Braunschweig (Germany, F.R.). Forschungs- und Messreaktor). Jul 1977. 18p. (In German). Dep. NTIS (US Sales Only), PC A03/MF A01.

In 1976 the Forschungs- und Messreaktor Braunschweig (FMRB) has been in action for 3,132 hours without any serious disturbance. The experience in the reactor operation, in the radiation protection work as well as in the experiments at the beam tubes is reported on.

37431 Experience in operation of the experimental atomic power plant "ARBUS" with the high-boiling organic coolant-moderator ditolylmethane. Tzikanov, V.A.; Aleksenko, Yu.N.; Tetyukov, V.D.; Kuprienko, V.A.; Kobzar, I.G.; Khramchenkov, V.A.; Mexcheryakov, M.P.; Zinoviev, V.I. (Scientific Research Inst. of Atomic Reactors, Dimitrovgrad, USSR). *Nucl. Technol.;* **38**: No. 2, 187-191(Apr 1978).

From Conference on low-temperature nuclear heat; Otaniemi, Finland (21 Aug 1977).

Radiolytic damage to the ditolylmethane organic coolant-moderator of the ARBUS reactor was removed by vacuum distillation. The majority of the degraded ditolylmethane formed gaseous and high-boiling materials, which were easily removed by the vacuum distillation. Unsaturated hydrocarbons and low-boiling residues were a minor contribution to the impurities produced by radiolysis in the primary coolant loop. Radioactivity in the primary coolant loop was found to be caused primarily from corrosion products of the system, ^{16}N from dissolved oxygen, and impurities in the coolant-moderator. These also were significantly reduced in the vacuum distillation process.

REACTOR SAFETY

REFER ALSO TO CITATION(S) 37711, 37966

37432 (CSNI—10) **Proceedings: Meeting of a Task Force on problems of rare events in the reliability analysis of nuclear power plants.** (Nuclear Energy Agency, 75 - Paris (France). Committee on the Safety of Nuclear Installations). 1976. 326p. (In French and English). (CONF-7606115—). Dep. NTIS (US Sales Only), PC A15/MF A01.

From Reunion du groupe special du CSIN sur les problemes d'evenments rares dans l'analyse de fiabilite des centrales nucleaires; Ispra, Italy (8 Jun 1976).

Twenty papers on reactor safety are presented concerning structures and systems; statistical techniques applicable to rare events; and reliability assessment of nuclear power plants.

37433 (GEAP-NUREG—21304-7) **BWR Blowdown/Emergency Core Cooling. Seventh quarterly progress report, July 1—September 30, 1977.** Schneidman, B. (General Electric Co., San Jose, Calif. (USA). Boiling Water Reactor Systems Dept.). Oct 1977. 34p. NTIS.

BD/ECC work completed included publication and distribution of BD/ECC1A test plan, comparisons of 7 x 7 BDHT test data versus 8 x 8 BDHT test data and BWR/4 versus BWR/6 system response, a number of scaling analyses, some modifications of the Two-Loop Test Apparatus (TLTA) and assembly of 8 x 8 BDHT bundle with scaled counter-current flow limiting (CCFL) simulation of a bundle exit.

37434 (GEFR—14034-13) **Radiological assessment models. Thirteenth quarterly report, September—November 1977.** (General Electric Co., Sunnyvale, Calif. (USA). Fast Breeder Reactor Dept.). Dec 1977. Contract EY-76-C-03-0893-015. 33p. .

The objective of the program is to develop models based upon analysis and experiment for determining: (a) the radiological source term resulting from the energetic phase of a hypothetical core disruptive accident, (b) the long duration radiological source term resulting from a core melt-through, and (c) the attenuation of radiological source terms within secondary containment. The discharge of fuel into a sodium pool as a result of an HCDA depends largely upon fuel pressure, heat transfer to structure and flow rates through channels. During this quarter, equations of state for fuel were examined and a theory was developed for evaluating choked flow rates. The theory compared favorably with test data. The BUBBLES code developed to calculate the collapse of vapor bubbles containing noncondensable gas was used to examine the effects of variations in the amount of gas. The code was improved and calculations were continued in order to determine bubble heat transfer parameters.

37435 (GRS-F—34) **List of the reports from reactor safety research of the BMFT and USNRC. Period under report: 1st of October to 31st of December 1976.** (Gesellschaft fuer Reaktorsicherheit m.b.H. (GRS), Koeln (Germany, F.R.)). Feb 1977. 63p. (In German). Dep. NTIS (US Sales Only), PC A04/MF A01.

This list presents a survey of reports from the FRG and USA issued on special problems of reactor safety research. The problems include emergency core cooling, the containment during loss of coolant, core meltdown, component safety, external impacts, risk and reliability, quality assurance, fission product transport, radiation exposure, as well as the LWR, HTR and the fast sodium-cooled reactor in general.

37436 (GRS-F—40) **Reports on the projects in the field of raactor safety sponsored by the Federal Ministry for Research and Technology.** (Gesellschaft fuer Reaktorsicherheit m.b.H. (GRS), Koeln (Germany, F.R.)). Jun 1977. 386p. (In German). Dep. NTIS (US Sales Only), PC A17/MF A01.

Investigations on the safety of Light Water Reactors (LWR) being performed in the framework of the Research Program Reactor Safety (RS-projects) are sponsored by the BMFT (Federal Minister for Research and Technology), Bundesminister fuer Forschung und Technologie. Objective of this program is to investigate in greater detail the safety margins of nuclear energy plants and their systems and the further development of safety technology. The GRS (Reactor Safety Association), Gesellschaft fuer Reaktorsicherheit mbH, by order of the BMFT, informs continuously of the status of these

investigations within the series 'GRS-F-Forschrittsberichte' (GRS-F-Progress Reports). Each progress report represents a compilation of individual reports about the different projects of the search program. The individual reports are prepared by the contractors themselves as a documentation of their progress in work and published by the GRS-FB (Research Coordination Department), Forschungsbetreuung at the GRS, within the framework of general information of the progress in reactor safety research. Each report describes the work performed, the results and the next steps of the work. The individual reports are attached to the classification system established by the CEC (Commission of the European Communities). The GRS-F-Progress Reports also include a list of the current investigations arranged according to the projects of the BMFT-Research Program Reactor Safety. This compilation, in addition to the LWR-investigations, also contains first contributions on the safety of advanced reactors.

37437 (JAERI-M—6925) **Review of irradiation experiments for water reactor safety research.** Tobioka, T. (Japan Atomic Energy Research Inst., Tokyo). Feb 1977. 143p. (In Japanese). Dep. NTIS (US Sales Only), PC A08/MF A01.

A review is made of irradiation experiments for water reactor safety research under way in both commercial power plants and test reactors. Such experiments are grouped in two; first, LWR fuel performance under normal and abnormal operating conditions, and second, irradiation effects on fracture toughness in LWR vessels. In the former are fuel densification, swelling, and the influence of power ramp and cycling on fuel rod, and also fuel rod behavior under accident conditions in in-reactor experiment. In the latter are the effects of neutron exposure level on the ferritic steel of pressure vessels, etc..

37438 (JAERI-M—6968) **ALARM-B1: a computer program for boiling water reactor blowdown analysis.** Akimoto, M. (Japan Atomic Energy Research Inst., Tokyo). Mar 1977. 41p. Dep. NTIS (US Sales Only), PC A03/MF A01.

The digital computer program ALARM-B1 written in FORTRAN-IV for FACOM 230-75 is for analyzing thermodynamic and thermal-hydraulic phenomena of BWR during a large break LOCA. The outputs are pressure, core inlet flow and enthalpy which affect core heat transfer during transients. In ALARM-B1, the heat transfer from core to coolant during transients is not calculated, but it is given as inputs. ALARM-B1 solves integral forms of fluid conservation and state equations for user-defined volumes (nodes) which are treated as one-dimensional homogeneous elements with interconnecting flow paths (junctions). The numbers of nodes and junctions and their initial fluid conditions are given as inputs. The program is of a variable dimension so there are no limits to the numbers of nodes and junctions.

37439 (JAERI-M—6981) **Report on series 3 reflood experiment.** Murao, Y.; Iguchi, T.; Sudoh, T.; Sudo, Y.; Sugimoto, J. (Japan Atomic Energy Research Inst., Tokyo). Mar 1977. 71p. (In Japanese). Dep. NTIS (US Sales Only), PC A05/MF A01.

Series 3 reflood experiment was carried out from December 1975 to January 1976. The purpose was to confirm temperature response and durability of the improved thermocouple installation and to examine system effect with parameters, flow housing temperature and primary loop flow resistance. The results are : 1) The improved thermocouples installation still has some problems, but is generally satisfactory up to 1000°C. 2) The flow housing temperature has large influence on the reflood phenomena, especially oscillation. 3) The primary loop resistance determines the flooding rate, and so influences the reflood phenomena.

37440 (JAERI-M—6983) **Data report on series 3 reflood experiment.** Iguchi, T.; Murao, Y.; Sudoh, T.; Sudo, Y.; Sugimoto, J. (Japan Atomic Energy Research Inst., Tokyo). Mar 1977. 298p. (In Japanese). Dep. NTIS (US Sales Only), PC A14/MF A01.

The data obtained in the Series 3 reflood experiment from December 1975 to January 1976 are presented. In this series experiment, the flow resistance in a primary loop and the temperature of the flow housing were parameters to be investigated. Performance and durability of the improved thermocouple attachment were also investigated.

37441 (JAERI-M—6984) **Study on quench phenomena during reflood phase. I. Quench models for bottom flooding.** Murao, Y.; Sudoh, T. (Japan Atomic Energy Research Inst., Tokyo). Mar 1977. 39p. Dep. NTIS (US Sales Only), PC A03/MF A01.

Based on the observation with an outside-heated quartz tube experiment of the reflood phase, three quench modes for bottom flooding are proposed : 1) liquid column type, 2) dryout type, 3) droplet-rewetting type. Using Blair's correlation for quench velocity, the approximate correlation for maximum liquid superheat, the assumption that the heat transfer upstream of the quench front is a function of the local liquid subcooling and the data of PWR-FLECHT experiments, the correlation for quench velocity of the liquid column type and of the dryout type are obtained. The quench temperature for the droplet-rewetting type is also derived. These relations are compared with the results of PWR-FLECHT Group 1 experiments and of Piggott and Porthouse's experiments. The agreements among them are fairly good.

37442 (JAERI-M—6985) **Study on thermocouple attachment in reflood experiments.** Sugimoto, J. (Japan Atomic Energy Research Inst., Tokyo). Mar 1977. 36p. (In Japanese). Dep. NTIS (US Sales Only), PC A03/MF A01.

The method of thermocouple attachment to a heater rods has been studied for surface temperature measurement in reflood experiments. The method used as far in JAERI's reflood experiments had some possibilities of not estimating exactly the quench times. Various attachment method have been tested and some proved to be effective in the respect.

37443 (JAERI-M—7037) **Analysis of LOFT (L1-2) experiment by code RELAP-4J.** Tasaka, K.; Soda, K.; Shiba, M.; Kaminaga, H. (Japan Atomic Energy Research Inst., Tokyo). Apr 1977. 141p. (In Japanese). Dep. NTIS (US Sales Only), PC A08/MF A01.

An analysis of the results in LOFT L1-2 LOCE (Loss of Coolant Experiment) was made by the computer code RELAP-4J. The L1-2 experiment is a simple isothermal blowdown test with a core simulator and no ECC activation. It provides the basis for future LOCE with a nuclear core and ECC activation. The results of the analysis lead to the following conclusions. (1) The calculated system pressure transient agrees well with experiment. Primary controlling factors for the calculation are (a) flow resistances of the steam generator simulator, pump simulator and discharge nozzle in the broken loop, (b) mixture level in the downcomer and inlet volume of the operating loop steam generator, and (c) stored heat of the downcomer structure. (2) The pressurizer pressure decreases rapidly, compared with experiment, possibly because the flow resistance in the surge line is smaller than the actual one. Further experiment and analysis are necessary in this respect. (3) The calculated density transient in the cold leg agrees well with experiment. Agreement is not good in the hot leg, however. The discrepancy is possibly caused by the non-homogeneous flow of coolant in the hot leg due to low flow rate. (4) Effect of the pump characteristics on analytical result is insignificant in the isothermal test. However, in the future nuclear test, the effect will be significant because of large steam generation in the core, so measurement of the pump characteristics and improvement of the pump model are necessary.

37444 (JAERI-M—7051) **Quarterly progress report on the NSRR experiments. III. Combined, July—December 1976.** Ishikawa, M.; Tomii, K. (Japan Atomic Energy Research Inst., Tokyo). Apr 1977. 141p. (In Japanese). Dep. NTIS (US Sales Only), PC A07/MF A01.

The program of NSRR experiments is directed at providing detailed data on fuel behaviours in reactivity-initiated accident (RIA) conditions. So far, over 90 experiments have been performed to determine the fuel failure threshold and to make clear failure mechanism in the RIA conditions for various types of unirradiated fuels such as pre-pressurized fuel, waterlogged fuel as well as standard fuel. The test series are those of scoping tests, fuel enrichment parameter tests, pre-pressurized fuel tests, wide gap fuel tests, flow-area simulation tests, bundle tests and waterlogged fuel tests. The objectives and main results in these tests are summarized in the table. A total of 55 tests among them were carried out during the two quarters from June to December 1976. The three test series, i.e. fuel enrichment parameter tests, pre-pressurized fuel tests and flow-area simulation tests were initiated in the current period. the results of tests, the present status of analytical works and future test plans. As concerns the figure of energy deposition, it has been evaluated on the basis of calculated results. However, the value by quantitative analysis of fission products in post-irradiation fuel is about 15% larger than the calculated one. The values of energy deposition presented in this report are subject to revision in the next progress report.

37445 (JAERI-M—7085) **Study of a UO_2 critical mass by calculation with a transport code XSDRN.** Kitano, T.; Ohnishi, N.; Saito, S.; Inabe, T.; Ishijima, K. (Japan Atomic Energy Research Inst., Tokyo). May 1977. 19p. (In Japanese). Dep. NTIS (US Sales Only), PC A03/MF A01.

A critical mass of UO_2 fuel was calculated with a transport code XSDRN to examine the effect of parameters such as U-235 enrichment and ratio of H/U-235 atomic density. Based on the results, the probability of re-criticality when molten UO_2 of a water reactor was collected, was examined. If only the UO_2 fuel gets together, a re-criticality does not occur under any conditions.

37446 (KFK—2435, pp 400-411) **Experiments on the determination and limitation of fission and activation product release during core meltdown.** Albrecht, H.; Nolte, K.; Wild, H. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer

Radiochemie); Perinic, D.; Kammerer, B.; Knauss, H.; Mack, A.; Stuka, B. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Abt. Reaktorbetrieb und Technik); Osborne, M.F. Apr 1977. (In German).

In Second semiannual report 1976.

In melting tests of 30 g corium specimens in air, a maximum release of 1.2 wt% was found at 2.850 +- 100°C. The most volatile elements were found to be Mn and Sb with relative release values (compared to the initial concentrations in the melt) of 11-17% at 2,850°C. The remaining steel components (Fe, Cr, Ni, Co) exhibited moderate volatility with release values between 1.0 and 5.0%. In the temperature region 2,100-2,900°C, all elements showed an increase in release of some two orders of magnitude. An increase in the gas pressure (air) lead to no measureable difference in release. In melting tests in argon and in Ar + 5% H_2, an unusual pressure-dependent behavior was discovered in the temperature region 2,600-2,800°C; the melt rose up in the crucible and there was a sudden initiation of bubbling or splattering, whereby small particles were thrown out of the crucible.

37447 (KFK—2435, pp 445-456) **Investigations on the interactions of fission products and aerosols in LWR-containments.** Bunz, H.; Haury, G.; Sack, C.; Schoeck, W. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Lab. fuer Aerosolphysik und Filtertechnik). Apr 1977. (In German).

In Second semiannual report 1976.

The version NAUA-Modla of the model contains the temperature dependence of steam content and steam pressure only. During the report period the new version Mod2 has been established containing all relevant temperature functions. These are mainly the viscosity which influences the aerosol removal mechanisms and some parameters which are used in the calculation of steam condensation. The temperature functions have been approximated by polynomials of such high order as is needed for the necessary accuracy. As a result of the sensitivity study the concept of the experimental facility has been undapted and the vessel has been ordered. The main change consists in elevated operating temperature (150°C) and pressure (7 bar) ranges. Now all possible states of steam saturation in the reactor containment can be simulated in the facility, too. Calculations on the feasibility of the planned experiments were positive without exception.

37448 (KFK—2435, pp 392-399) **Experimental investigations of the meltdown phase of UO_2-Zircaloy fuel rods under conditions of failure of emergency core cooling.** Hagen, S.; Mackert, E.; Malauschek, H.; Schuelken, H.; Wallenfels, K. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Abt. Reaktorbetrieb und Technik). Apr 1977. (In German).

In Second semiannual report 1976.

The tests for fuel rod simulators with central tungsten rods have shown that the heating within the bundle arrangement is according to the expectations, thus the bundle experiments can be carried out. First experiments with solid pellets heated with the radiation furnace show that the interaction between Zircaloy and UO_2 in this case is the same as using the tungsten rod simulator.

37449 (KFK—2435, pp 224-246) **Theoretical investigations of the fuel rod behavior during a LOCA.** Meyder, R. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Reaktorentwicklung); Unger, U. (Stuttgart Univ. (TH) (Germany, F.R.). Inst. fuer Kernenergetik). Apr 1977. (In German).

In Second semiannual report 1976.

During the period reported on, the use of SSYST-Mod 1 was increased. In former times the work was primarily concentrated on analysing the blowdown test-rig PNS 4236. The LOCA is considered for a PWR. The description of SSYST was completed. A shortened version was incorporated into the SSYST-library 'BASIS'. Work on SSYST-Mod 2 was continued. The module for subchannel thermohydraulics during blowdown was tested, work on the correspondent module for refill and reflood phases was continued. The module for rod mechanics was revised. Work on determining improved diffusion coefficients for oxygen in Zry-cladding is completed. To determine creep coefficients for Zry, tensile-test-data from PNS 4235.1 were used in the temperature range of 870 K to 1020 K. For the statistical description of cladding deformation during a LOCA alternative methods were analyzed.

37450 (KFK—2435, pp 433-437) **Technology and properties of corium melts.** Nazare, S.; Ondracek, G. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Material- und Festkoerperforschung). Apr 1977. (In German).

In Second semiannual report 1976.

The general aim of the program is to provide data on the behavior of the core materials in a core meltdown accident with a view to assessing its course and consequences. One of the main objectives in the past has been the preparation of various types of core melts (corium) which arise under varying oxidation conditions which might exist in the accident environment. The determination of properties such as thermal conductivity, thermal expansion, density, as well as the nature of the melt that exists in contact with concrete has been started. Up to now estimates of properties such as thermal conductivity, viscosity and heat capacity, have been carried out and partly verified. Methods of preparation of Corium melts under inert gas conditions have been established. Experiments are underway to determine the interaction of corium with concrete.

37451 (KFK—2435, pp 438-444) **Experiments with simulated large core melts.** Perinic, D.; Kammerer, B.; Mack, A.; Stuka, B. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Abt. Reaktorbetrieb und Technik). Apr 1977. (In German).

In Second semiannual report 1976.

Preliminary investigations were conducted with three different melt masses (0.1 - 1 - 10 t). The maximum power generated with the melt was determined. The maximum local power density at the melt front may be as high as 3 MW/m^2 because of the cooling of the melt. To simulate the accident atmosphere a pressure vessel capable of 6 bar will be required. In any case the melt will be covered with steam. However the containment pressure may be simulated by noncodensable gas (with cold pressure vessel walls) or with steam (with hot walls). Preliminary experiments to investigate electrical discharge within these atmospheres will be required. Additional following investigations were conducted: Chemical reactions on the melt surface, gas filtering, melt composition, fissium production and analysis, temperature measurement, handling of radioactive waste, experimental building.

37452 (KFK—2435, pp 108-112) **Post-accident recirculation filters for removal of fission products from the atmosphere of the safety containments.** Dillmann, H.G.; Pasler, H. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Lab. fuer Aerosolphysik und Filtertechnik). Apr 1977. (In German).

In Second semiannual report 1976.

Testing of the iodine sorption filter was terminated. Except for the results of missing irradiation tests with the iodine loaded sorption material, the measurements have shown that the conditions to be expected after serious accidents ($<= 300°C$, $p <= 5$ bar) can be controlled by the use of molecular sieves in the silver form provided that by preliminary droplet removal and temporary afterheating a relative gas humidity higher than 85% can be avoided. At present, droplet removal tests are being performed with an improved wave plate droplet separator. For small droplet diameters between 5 and 10 μm removal efficiencies between 93 and 99% were obtained at a mass concentration up to 50 g/m^3. The removal efficiency rises with the drops getting larger. The conduction of performance tests on the aerosol generator destined for the filter test rig will be terminated shortly.

37453 (KFK—2435, pp 332-336) **Investigation of the fuel-rod-behavior during the blowdown-phase of a loss-of-coolant-accident.** Class, G.; Foempe, D. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Reaktorentwicklung); Hain, K.; Bruederle, F.; Paroth, N.; Vollmer, T.; Wagner, K. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Abt. Reaktorbetrieb und Technik). Apr 1977. (In German).

In Second semiannual report 1976.

The test-loop reached the nominal operating values on Oct. 18 for the first time. The tests of single component groups including the rod-simulator yielded satisfactory results. However, delays occurred in the realization of measured values recording and component control and in the fabrication of the true-mass flowmeter. A RELAP 4-version for the thermohydraulic interpolation in the test section was completed and worked satisfactory during performed tests. Also the parts of the evaluation program for the calculation of the heat transfer coefficients and for data conversion and consistency verification, too, essentially have been completed and tested. (orig./RW).

37454 (KFK—2435, pp 337-360) **Investigations of fuel rod failure in the second heatup phase of a LOCA. In-pile experiments with single rods in the DK-loop of the FR2 reactor.** Karb, E.; Sepold, L.; Harbauer, G.; Junker, H.; Legner, W.; Leiling, W.; Lukitsch, H.; Raepple, B.; Baumgaertner, K.; Hespeler, M. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Abt. Reaktorbetrieb und Technik). Apr 1977. (In German).

In Second semiannual report 1976.

Within the second half of 1976 the nuclear rod tests were given priority over the BSS-tests. Five nuclear rod tests in total were performed. Three tests completed the scoping test series. In this test series the internal pressure and axial power profiles were varied. The design data of modern PWR's (45 to 100 bar) were taken as the range of internal pressures. In one test the internal pressure was adjusted to 25 bar. Post-test examinations of the first two rods exposed to transients in Oct 1975 were meanwhile completed in the Hot Cells; other rods from tests in 1976 are presently examined. In 12 test series with the electrical fuel rod simulators BSS 05 and BSS 06 (calorimeter) the following problems were tackled: a) BSS 05: 1)

'true' cladding tube temperature, 2) comparison of thermal power with electrical power, 3) influence of reactor power (γ-heat). b) BSS 06: 1) comparison of thermal power with electrical power.

37455 (NEDO—21617-1) **Analog transmitter/trip unit system for engineered safeguard sensor trip inputs. Amendment No. 1.** Strong, R.W.; Youngborg, L.H. (General Electric Co., San Jose, Calif. (USA). BWR Projects Dept.). Jan 1978. 38p. Electric Co., San Jose, CA.

Revised and additional information on the General Electric analog transmitter/trip unit system for BWR engineered safety systems is presented.

37456 (NUREG/CR—0002) **Bubble behavior in LMFBR core disruptive accidents. Annual report, July 1, 1976—September 30, 1977.** Erdman, C.A.; Reynolds, A.B. (Virginia Univ., Charlottesville (USA). Dept. of Nuclear Engineering and Engineering Sciences). Dec 1977. 126p. (UVA—529106/NE77/103). NTIS $7.25.

Analytical research in three major areas is described: (1) particle production by homogeneous nucleation, (2) fuel condensation on above-core structure, and (3) small particle production by hydrodynamic fragmentation. Preliminary results on minimum expected particle sizes for one stage of LMFBR core disruptive accidents are presented along with work on time scales for fragmentation and a status report of current efforts.

37457 (ORNL/NUREG/CSD/TM—6) **ORNL: PWR-BDHT analysis procedure, a preliminary overview.** Cliff, S.B. (Oak Ridge National Lab., Tenn. (USA)). 10 Jan 1978. Contract W-7405-ENG-26. 24p. Dep. NTIS, PC A02/MF A01.

The computer programs currently used in the analysis of the ORNL-PWR Blowdown Heat Transfer Separate-Effects Program are overviewed. The current linkages and relationships among the programs are given along with general comments about the future directions of some of these programs. The overview is strictly from the computer science point of view with only minimal information concerning the engineering aspects of the analysis procedure.

37458 (ORNL/NUREG/TM—175) **Blowdown heat transfer separate-effects program. Quarterly progress report, October—December 1977.** Thomas, D.G.; Baucum, W.E.; Bohanan, R.E. (Oak Ridge National Lab., Tenn. (USA)). Oct 1977. Contract W-7405-ENG-26. 77p. Dep. NTIS, PC A05/MF A01.

The Thermal-Hydraulic Test Facility (THTF) has completed 20 powered rod blowdowns through October 13, 1977. Of these blowdowns, 5 were completed with all 49 rods powered, 2 were completed with 2 inactive rods, and 13 were completed with 4 inactive rods. Initial system pressure was 15.5 MPa, test section inlet temperature was 559 K, and break area was equivalent to a 200% break with the total area usually split between inlet and outlet in the ratio 0.40 : 0.60. Heater rod power was 80, 100, or 122 kW/rod, and the test section temperature was 607 K, 598 K, or 589 K. Mean time to critical heat flux (CHF) varied from 0.7 to 1.4 sec with delayed CHF of 2.5 sec occurring in the upper half of the bundle in some tests.

37459 (ORNL/NUREG/TM—183) **Advanced two-phase instrumentation program. Quarterly progress report, July—September 1977.** Jallouk, P.A.; Leavell, W.H.; Shahrokhi, F. (Oak Ridge National Lab., Tenn. (USA)). Apr 1978. Contract W-7405-ENG-26. 40p. Dep. NTIS, PC A03/MF A01.

An extensive series of tests was conducted to determine the useful operational range of a string conductivity probe. Noise analysis techniques were applied to determine several parameters, including amplitude probability densities, power spectral densities, coherence, and transfer function phase shift. The string probe appeared to operate well in the low to intermediate void fraction range. Discrepancies were noted between the liquid and vapor velocities computed from various holdup correlations in the literature and the velocity determined from noise analysis techniques applied to the 0-20 Hz frequency range. These may be attributed to the nonlinearity of the phase shift curve and the small frequency range analyzed. Relocation of the string probe away from a tee in the air-water system has resulted in a linear phase shift curve and closer agreement between measured two-phase velocities and those predicted by noise analysis.

37460 (ORNL/NUREG/TM—187) **PWR Blowdown Heat Transfer Separate-Effects Program. Thermal-Hydraulic Test Facility experimental data report for test 103.** Clemons, V.D.; White, M.D.; Moore, P.A.; Hedrick, R.A. (Oak Ridge National Lab., Tenn. (USA)). 7 Mar 1978. Contract W-7405-ENG-26. 48p. NTIS, PC E03/MF A01.

Reduced instrument responses are presented for Thermal-Hydraulic Test Facility (THTF) test 103, which is part of the ORNL Pressurized-Water Reactor (PWR) Blowdown Heat Transfer Separate-Effects Program. The objective of the program is to investigate the thermal-hydraulic phenomenon governing the energy transfer and transport processes that occur during a loss-of-coolant accident in a PWR system.

37461 (ORNL/NUREG/TM—188) **PWR Blowdown Heat Transfer Separate-Effects Program: Thermal-Hydraulic Test Facility experimental data report for test 151.** Leon, D.M.; White, M.D.; Hedrick, R.A. (Oak Ridge National Lab., Tenn. (USA)). Mar 1978. Contract W-7405-ENG-26. 50p. NTIS, PC E02/MF A01.

Reduced instrument responses are presented for Thermal-Hydraulic Test Facility (THTF) test 151, which is part of the ORNL Pressurized-Water Reactor (PWR) Blowdown Heat Transfer Separate-Effects Program. The objective of the program is to investigate the thermal-hydraulic phenomenon governing the energy transfer and transport processes that occur during a loss-of-coolant accident in a PWR system. Test 151 was conducted to obtain CHF information in the THTF bundle 1 containing four unpowered rods.

37462 (SGAE—2572) **Application of the reactor kinetics equations to the reactor safety analysis.** Sdouz, G. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Vienna). Jan 1976. 17p. (In German). (RT—100/76). Dep. NTIS (US Sales Only), PC A03/MF A01.

The reactor kinetics equations which can be solved by the computer program AIREK-III are used to describe the behavior of fast reactivity transients. By supplementing this computer program it was possible to solve additional safety problems, e.g. the course of reactor excursions induced by any form of reactivity input, the control of reactivity input as a function of a threshold-energy and the computation of produced energy.

37463 **Condensed review of the technology of post-accident heat removal for the liquid-metal fast breeder reactor.** Kazimi, M.S. (Massachusetts Inst. of Tech., Cambridge); Chen, J.C. *Nucl. Technol.;* **38**: No. 3, 339-366(May 1978).

The analyses performed to evaluate the capacity to contain the core materials after a hypothetical core meltdown accident are generally grouped under the area of post-accident heat removal (PAHR). Substantial advancement in the state-of-the-art of the PAHR area has occurred within the last few years. The key issues of PAHR, as applied to safety analyses of liquid-metal breeder reactors, are summarized. The review includes heat source strength for post-accident conditions, in-vessel core debris retention, ex-vessel core debris retention, and the effects of alternate fuel materials.

37464 **Optimum supervision intervals and order of supervision in nuclear reactor protective systems.** Kontoleon, J.M. (Univ. of Wollongong, New South Wales, Australia). *Nucl. Sci. Eng.;* **66**: No. 1, 9-13(Apr 1978).

The optimum inspection strategy of an m-out-of-n:G nuclear reactor protective system with nonidentical units is analyzed. A 2-out-of-4:G system is used to formulate a multi-variable optimization problem to determine (a) the optimum order of supervision of the units and (b) the optimum supervision intervals between units. The case of systems with identical units is a special case of the above. Numerical results are derived using a computer algorithm.

37465 **Probabilistic accident analysis with deterministic codes using stochastically variable parameters.** Abramson, P.B.; Hummel, H.H.; Gelbard, E.M.; Pizzica, P.A.; Sienicki, J.J. (Argonne National Lab., IL). *Nucl. Sci. Eng.;* **66**: No. 1, 14-23(Apr 1978).

In the use of large computers to analyze severe accidents in liquid-metal fast breeder reactors (LMFBRs), it has long been recognized that many of the fundamental phenomena cannot be precisely predicted because of uncertainty in the parameters that govern them. As a direct result, mechanistic analysis of such accidents has proceeded along a parametric path in which these variables are fixed at a certain constant value for the entire calculation: The influence of variation of this value is assessed by making a series of complete calculations with the parameter set at a different value for each such element of the series. While some parameters may be thought of as "correlated" or fixed for an entire calculation, very few are in fact constant throughout a reactor, and many are (for practical purposes) nearly completely uncorrelated, either in space or time, during the hypothetical accident. Thus, such analysis has created a set of results that are not indicative or representative of an accident involving uncorrelated or only partially correlated variable parameters. A methodology is described for dealing with various degrees of uncertainty or incoherence in these parameters. By using two very different mechanistic codes (FX2-POOL and EPIC), we demonstrate that the treatment of uncorrelated parameters, such as droplet/particle size in a hypothetical core disruptive accident, as random variables with a certain probability distribution during each complete calculation of a series of calculations produces as much as an order of magnitude less uncertainty in the end result than had been obtained assuming perfect correlation. A small list of parameters is categorized as either correlated or uncorrelated for some of the other LMFBR accident analysis codes. The technique can be easily imple-

mented in a broad spectrum of accident analysis codes with similar benefits.

37466 Experimental investigation of gas evolution as the mechanism for free-contact fragmentation. Shiralker, G. (Univ. of California, Berkeley); Rohsenow, W.; Sonin, A.; Todreas, N. *Nucl. Sci. Eng.;* **66**: No. 1, 103-109(Apr 1978).

An experimental investigation was made to assess the hypothesis of Epstein that violent release of dissolved gas upon rapid cooling of a molten metal is responsible for observed free-contact fragmentation. Results from quenching tin drops initially heated in vacuum and air to develop drastic initial differences in oxygen solubility levels did not demonstrate any differences in observed fragmentation occurrence or intensity. It is concluded that this hypothesis is not the operative mechanism for free-contact fragmentation in the tin-water system.

37467 Pressurized-water reactor coolant pipe containment. Schabert, H.P.; Irion, L.; Braun, W. (to Kraftwerk Union AG). US Patent 4,077,837. 7 Mar 1978. Priority date 9 Apr 1974, German, Federal Republic of (F.R. Germany). 6p.

A pressurized-water reactor coolant system has a main coolant pipe connecting with the reactor pressure vessel through a check valve. A tubular containment is fixed to the pressure vessel and extends over the check valve and connects with the pipe beyond the check valve.

37468 Fuse and application of said fuse to the construction of an emergency shutdown system for a nuclear reactor. Taulier, H.H.L.; Brugeille, G. (to Electricite de France (Service National)). US Patent 4,076,587. 28 Feb 1978. Filed date 1 Mar 1976. 8p.

A fuse device for an automatic emergency shutdown system in fast reactors provides a coupling between a casing tube placed within a fuel can and a series of neutron-absorbing masses held together above the reactor core under normal operating conditions but released in free fall to the lower portion of the casing tube at the level of the reactor core as a result of melting of the fuse when operating characteristics such as temperature or neutron flux attain a level which exceeds a predetermined threshold.

37469 Nuclear reactor core catching apparatus. Barleon, L.; Dorner, S.; Goetzmann, O.; Kussmaul, G. (to Gesellschaft fuer Kernforschung). US Patent 4,073,682. 14 Feb 1978. Priority date 21 Dec 1973, German, Federal Republic of (F.R. Germany). 4p.

An apparatus for containing the components of a nuclear reactor core during a core-melt-down accident, comprising a container consisting at least its inner surface of a highly temperature resistant material. 5 claims, 4 figures.

37470 Bottom cooler for nuclear reactors. Friedrich, H.J. (to Interatom, Internationale Atomreaktorbau GmbH). US Patent 4,072,561. 7 Feb 1978. Priority date 11 Aug 1975, German, Federal Republic of (F.R. Germany). 6p.

A cooler for a bottom tray of a liquid metal-cooled nuclear reactor is described, the tray serving as a receptacle for a melting reactor core in the event of a hypothetical accident, comprising coolant distribution and collecting pipes disposed below the bottom tray about the circumference thereof, and a plurality of parallel tubes connecting said distribution and collecting pipes, said tubes being in the shape of involutes running between the center and circumference of said tray. 7 claims, 4 figures.

37471 Pressurized-water reactor pressure vessel emergency core coolant connection arrangement. Seidelberger, E. (to Kraftwerk Union Aktiengesellschaft). US Patent 4,072,560. 7 Feb 1978. Priority date 26 Sep 1974, German, Federal Republic of (F.R. Germany). 4p.

In a nuclear reactor, a line for supplying emergency coolant is connected directly to the reactor pressure vessel and equipped in the interior of the latter with an emergency coolant flow-directing device whose exit runs parallel to the wall of the pressure vessel in a direction toward the lower edge of the core. The invention provides, particularly in pressurized-water reactors, more rapid flooding of the reactor core in case of a loss-of-coolant accident. 3 claims, 3 figures.

37472 Influence of changes in the basic assumptions underlying computation upon the calculated pressure development in the containment during a LOCA. Nowak, K. (Technischer Ueberwachungs-Verein Rheinland e.V., Duesseldorf (Germany, F.R.). Arbeitsgemeinschaft Kerntechnik West). *Atomwirtsch., Atomtech.;* **22**: No. 11, 581-583(Nov 1977). (In German).

4 figs.; 1 tab.; 11 refs.

With the computer code ZOCO VI a parametric study was carried out checking the influence of the following assumptions on the calculated pressure development: 1) efflux function: nozzle resp. orifice flow 2) thermodynamic state: equilibrium resp. superheating. With the theoretical efflux function for nozzles, distinctly higher absolute and differential pressures in the neighborhood of the break will be obtained than those calculated with the efflux function for orifice flow. This effect is especially strong for supercritical pressure conditions.

37473 Analysis of occupational radiation exposure experienced at pressurized water reactor plants. Kuwashima, K. (Kansai Electric Power Co., Inc., Osaka (Japan)). *Genshiryoku Kogyo;* **23**: No. 6, 20-24(Jun 1977). (In Japanese).

Among the pressurized water reactors of Kansai Electric Power Co., Reactor Mihama No. 2 (500 MWe), No. 3 (826 MWe), Takahama No. 1 and No. 2 (both with 826 MWe) have now been operated since Reactor Mihama No. 1 (340 MWe) was first operated in Nov. 1970. Oi No. 1 and No. 2 (both with 1175 MWe) are scheduled to start operation during 1978. No engineer has been exposed excessively so far but very strict control is carried out to prevent excess exposure in the future. The statistics of exposed condition for 6 years in operation investigated by the film badge were analyzed by the computer. The records of pressurized water reactors in USA are examined to make future guide for radioactive ray control.

37474 Review of current status of LWR safety research in Japan. Yamada, T. (Atomic Energy Commission, Tokyo (Japan)); Mishima, Y.; Ando, Y.; Miyazono, S.; Takashima, Y. *Nippon Genshiryoku Gakkaishi;* **19**: No. 3, 125-158(Mar 1977). (In Japanese).

The Japan Atomic Energy Commission has exerted efforts on the research of the safety of nuclear plants in Japan, and "Nuclear plant safety research committees" was established in August 1974, which is composed of the government and the people. The philosophy of safety research, research and development plan, the forwarding procedure of the plan, international cooperation, for example LOFT program, and the effective feed back of the experimental results concerning nuclear safety are reviewed in this paper at first. As for the safety of nuclear reactors the basic philosophy that radio active fission products are contained in fuel or reactors with multiple barriers, (defence in depth) and almost no fission product is released outside reactor plants even at the time of hypothetical accident, is kept, and the research and development history and the future plan are described in this paper with the related technical problems. The structural safety is also explained, for example, on the philosophy "leak before break", pipe rupture, pipe restraint and stress analysis. The release of radioactive gas and liquid is decreased as the philosophy "ALAP". And probability safety evaluation method, LOCA, reactivity, accident and aseismatic design in nuclear plants in Japan are described.

37475 (NUREG/TR—0023) Human components in initiating phenomena of nuclear accidents. Translation Series. Carnino, A.; Raggenbass, A. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)). Mar 1977. Translation of DSN/77 270. (CONF-770220—4). 19p. Regulatory Commission, Washington, DC.

From International symposium on the handling of radiation accidents; Vienna, Austria (2 Feb 1977).

Portions of document are illegible.

Starting in 1967, the Department of Nuclear Safety of the French Atomic Energy Commission has put out an informative file presenting a collection of all the operational incidents of French nuclear reactors. The users of the nuclear centers themselves fill out the reports for this file. These incidents are classified with regard to their importance for the safety of the installation. Most are found in the category of little importance for safety but potentially the effects could have been serious if the safety devices and the automatic devices had not functioned. In researching the incidents connected to human parameters, reference is made to three large categories: error of conduct, error of maintenance, and human error. It was concluded that about 10% of the incidents had a human origin. Examining these incidents in detail, it was found that only three led to radiological consequences (limited elsewhere), the others always having been stopped by automatic and safety devices.

37476 Loss-of-coolant accidents. Chapter 20. Brittain, I. (UKAEA Reactor Group, Winfrith. Atomic Energy Establishment). pp 463-477 of Two-phase flow and heat transfer. Butterworth, D.; Hewitt, G.F. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment) (eds.). Oxford; University Press (1977).

This chapter is an introduction to loss-of-coolant accidents (LOCA) in water-cooled reactors from the viewpoint of safety analysis. The criteria for fuel integrity and the course of a typical LOCA are described in general terms to cover both light-water reactors and the steam-generating heavy-water reactor. Emphasis is placed on the heat transfer and two-phase flow aspects of the analysis, the topics covered including critical flow, use of steady-state heat-transfer and burnout correlations, pump modelling, and steam-drum behaviour.

37477 Mass flow measurements of unsteady two-phase flows using radionuclide techniques. Loeffel, R. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Lab. fuer Isotopentechnik). *KFK Nachr.;* **9**: No. 2, 38-42(1977). (In German).

10 figs.; 4 refs.

Among others, radionuclide techniques have been tested in the Marviken-II blowdown experiments in preparation for the HDR test programme. Velocity measurements with the aid of tracers - ^{41}Ar (gaseous), ^{56}Mn (liquid) - have been carried out in one of the four relief channels and in the fracture nozzle. In the latter, density measurements were also made with a two-beam absorption method - ^{170}Tm, ^{192}Ir, ^{137}Cs, depending on the pipe diameter and density region. The measuring principle and the results obtained, which seem to be very promising, are shortly outlined.

37478 Design measures to minimise radiation exposure of staff for a commercial nuclear power plant. Keenan, F. (South of Scotland Electricity Board, Glasgow (UK)); Pugh, I.G.; Youell, F.P. *Atomkernenergie;* **30**: No. 4, 287-289(1977).

From 5. international reactor shielding conference; Knoxville, Tenn. (18 - 22 Apr 1977).

3 tabs.; 2 refs.

World wide experience with nuclear power plants has highlighted the problem of radiation exposure of station staff. In the design of future UK plants the problem has been further emphasised by the adoption for design purposes, of reduced exposures to operators. For design purposes 1 rem/year per operator will be used. The paper discusses the design criteria for station design and describes measures incorporated the minimise staff radiation exposure using the Commercial Steam Generating Heavy Water Reactor (CSGHWR) as an example. A dose budgeting procedure is outlined and as part of this process station man-rem budgets have been established and man-rem estimates have been made for carrying out all normal operations, inspection and maintenance work. The provisional results of implementing this procedure are given.

37479 Experience with occupational radiation exposure in PWRs built by Kraftwerk Union. Hecht, G. (Kraftwerk Union A.G., Erlangen (Germany, F.R.)). *Atomkernenergie;* **30**: No. 4, 290-292(1977).

From 5. international reactor shielding conference; Knoxville, Tenn. (18 - 22 Apr 1977).

3 tabs.; 3 refs.

The total radiation exposure to the plant personnel has gained increasing interest during the past few years. From this point of view, the exposure effect of different work procedures has to be analysed besides the exposure to the individual. A summary of the available data is given with indication of the essential influences. The exposures during refuelling outages may amount to about 50 to 90% of the yearly dose. Twelve years of operation of three plants result in an average of 0.61 man-rems per megawatt-year.

37480 Structural mechanics in reactor technology. Vol. K(b). Seismic response analysis of nuclear power plant systems. Jaeger, T.A.; Boley, B.A. (eds.). Brussels; Commission of the European Communities (1977). 406p. (CONF-770807—Pt.K(b)).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

This volume covers sessions on seismic response analysis of nuclear power plant systems. Separate abstracts were prepared for each of the individual papers included.

37481 Structural mechanics in reactor technology. Vol. K(a). Seismic response analysis of nuclear power plant systems. Jaeger, T.A.; Boley, B.A. (eds.). Brussels; Commission of the European Communities (1977). 486p. (CONF-770807—Pt.K(a)).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

This volume covers sessions on seismic response analysis of nuclear power plant systems. Separate abstracts were prepared for each of the individual papers.

37482 Structural mechanics in reactor technology. Vol. J(b). Loading conditions and structural analysis of reactor containment. Jaeger, T.A.; Boley, B.A. (eds.). Brussels; Commission of the European Communities (1977). 385p. (CONF-770807—Pt.J(b)).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

This volume covers sessions on loading conditions and structural analysis of reactor containment. Separate abstracts were prepared for each of the individual papers.

37483 Structural mechanics in reactor technology. Vol. E. Structural dynamics in fast reactor accident analysis. Jaeger, T.A.; Boley, B.A. (eds.). Brussels; Commission of the European Communities (1977). 404p. (CONF-770807—Pt.E).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

This volume covers the sessions on structural dynamics in fast reactor accident analysis. Separate abstracts were prepared for each of the individual papers included.

37484 Structural mechanics in reactor technology. Vol. J(a). Loading conditions and structural analysis of reactor containment. Jaeger, T.A.; Boley, B.A. (eds.). Brussels; Commission of the European Communities (1977). 440p. (CONF-770807—Pt.J(a)).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

This volume covers sessions on loading conditions and structural analysis of reactor containment. Separate abstracts were prepared for each of the individual papers included.

37485 Method of and device for screening the source of rays dangerous to human health. Bueth, H.W.; Stuermer, H.; Bock, A. (to L. and C. Steinmuller GmbH). US Patent 3,995,165. 30 Nov 1976. Priority date 10 Dec 1973, German, Federal Republic of (F.R. Germany). 4p.

A method of and device for quickly and safely shielding a localized source of rays, according to which easily movable frame means are placed around the localized source of rays and shielding means nonpenetrable by the rays of the localized source of rays are by remote control inserted into the frame means.

ENERGY STORAGE

MAGNETIC

37486 (LA—7150-PR) Superconducting Magnetic Energy Storage Project at LASL. Progress report, January 1—June 30, 1977. Hassenzahl, W.V. (comp.). (Los Alamos Scientific Lab., N.Mex. (USA)). Mar 1978. Contract W-7405-ENG-36. 32p. Dep. NTIS, PC A03/MF A01.

Details are reported on part of the design of 10-MWh and 10^4-MWh Superconducting Magnetic Energy Storage (SMES) units; several superconducting wires were tested; and a study was completed to determine candidate 30-kA conductors that could be made in a modular form and used in large SMES magnets. Ac-dc-ac converters, operating in both symmetric and antisymmetric modes, were tested to determine harmonic content and reactive power requirements. Circuit improvements during this period have reduced the switching time from charge to discharge, and vice versa, from 20 milliseconds to the theoretical limit of four to seven milliseconds.

COMPRESSED GAS

37487 Compressed-air energy storage. Vosburgh, K.G. (General Electric Co., Schenectady, NY). pp 17-25 of New options in energy technology. New York; American Institute of Aeronautics and Astronautics, Inc. (1977).

From Conference on new options in energy technology; San Francisco, CA, USA (2 Aug 1977).

See CONF-770824—.

Compressed air energy storage (CAES) systems are being developed for peak load leveling applications by electric utilities. Energy is stored by compresing air in an underground reservoir; when power is required, the air is heated and expanded through a turbine-generator system. Several CAES plants are being designed, and construction of the first large scale plant will be completed late this year. From the specifications of these systems, it is concluded that CAES systems appear to be economically favored over gas turbines and other near-term utility storage systems for a substantial range of costs of fuel and off-peak charging power.

PUMPED HYDRO

37488 High-speed large-capacity pumped storage equipment for Okuyoshino Power Station. Takahashi, J.; Hioki, T.; Harada, K.; Shirasu, K.; Furusawa, T.; Kato, N. *Toshiba Rev., Int. Ed.;* No. 112, 33-39(1977).

The design of the Okuyoshino pumped-storage hydroelectric power plant, and the design, operation and testing of its pump-turbine and generator motor components are discussed. This is the world's largest pumped storage equipment operating under 526 m maximum net head with 270 MW output and at a speed of 514 rpm. The first unit is scheduled to commence commercial operation in July 1978. (LCL)

37489 Results of field test on 310MW Francis pump turbines. Sono, M. (Takasago Machinery Works, Japan); Ueyama, T.; Yoneda, Y. *Tech. Rev., Mitsubishi Heavy Ind.;* **13**: No. 3, 203-212(Oct 1976).

The four 310 MW Francis pump turbines installed in the Okutataragi Power Station have the largest unit capacity in Japan and are designed to operate under net head of 400 m. Two of the four water turbines were designed, manufactured, and installed by our company. The results of the field tests of these pump turbines were of interest as indicating a new trend in high-head large-capacity pump turbines for pumping-up power stations. Various kinds of field tests were conducted and a stress-measuring test was given to the two-split runners. The results of these tests proved that these pump turbines have better operating characteristics than expected. The results of the tests are described in comparison with the results of model tests and theoretical analysis.

THERMAL

REFER ALSO TO CITATION(S) 37106, 37114, 37145, 37578

37490 Thermal storage for electric utilities. Swet, C.J. (Energy Research and Development Administration, Washington, DC); Masica, W.J. pp 26-32 of New options in energy technology. New York; American Institute of Aeronautics and Astronautics, Inc. (1977).

From Conference on new options in energy technology; San Francisco, CA, USA (2 Aug 1977).

See CONF-770824—.

Thermal energy storage can play major roles in several areas of the electric utility industry. It can level loads on the customer side of the meter, add peak load following capability to coal or nuclear fueled base load stations, make possible the economical generation of thermal electric power from the sun, and facilitate the utilization of thermal power plant reject heat for district heating or industrial processes. Functional requirements, candidate technologies, and prospects for commercialization are discussed.

BATTERIES

DESIGN AND DEVELOPMENT

37491 (COO—2949-1) **Iron—air battery development program. Interim report, June 1976—June 1977.** Buzzelli, E.S. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA)). Sep 1977. Contract EY-76-C-02-2949. 154p. Dep. NTIS, PC A08/MF A01.

The research and development efforts of the program at the Westinghouse Electric Corporation on iron—air batteries during the period June 1976—May 1977 are described. This battery is being developed for electric-vehicle propulsion. The present cell uses a bifunctional air electrode in combination with a high-performance iron electrode, operating at ambient temperature in KOH electrolyte. Objectives for both electrodes and cells were established to be compatible with a final, fully engineered battery which will store greater than 110 Wh/kg (50 Wh/lb) and deliver greater than 88 W/kg (40 W/lb). Work, during this portion of the development program, concentrated on advancing and upgrading the performance and life of both electrodes. The air electrode performance characteristics for this portion of the program were established for 300 cycles. Additional work in cell development showed energy storage densities at about 80% of the expected goal, with polarization (power profiles) compatible with the goals. Fabrication, composition, testing, and life characteristics of both the iron and air electrodes were studied with several approaches. The cyclic voltage efficiency of the air electrode was investigated in order to improve the overall energy efficiency of the system to >50%. Progress toward reducing the oxygen overvoltage and improving the oxygen reduction potential in low-cost structures was made. The performance of the iron electrode, at 0.4 ampere hours/gram in a cell configuration was also accomplished. Long-term cyclic stability of greatr than 500 cycles on the air electrode and greater than 100 cycles in full cells was not achieved. Continuing programs are presently underway to increase the cyclic life of both air electrodes and cells, while also improving energy efficiency.

37492 Rechargeable galvanic cell with zinc electrode and auxiliary structure. Benczur-Uermoessy, G.; von Benda, K.; Haschka, F. (to Deutsche Automobilgesellschaft mBh, Firma). US Patent 4,039,729. 2 Aug 1977. Priority date 9 May 1974, German, Federal Republic of (F.R. Germany). 14p.

A rechargeable galvanic cell has a housing containing at least one negative zinc electrode, at least one positive metal oxide or oxygen electrode, an alkaline electrolyte, at least one electrically conductive auxiliary structure exhibiting low hydrogen overvoltage (for cathodic hydrogen evolution) which is not conductively connected with the electrodes, and at least one microporous separator for separating the auxiliary structure from at least one of the electrodes. The structure simultaneously acts as an auxiliary electrode to effect afterdischarging of the zinc electrode when connected to it and as a dendrite barrier to prevent short-circuiting between the negative and positive electrodes during operation of the cell. The structure is arranged between one positive electrode and one negative electrode.

37493 Rechargeable gel cells: the way ahead. Bradley, B. *Electron (London);* No. 92, 50(25 Mar 1976).

Dc power sources are frequently taken for granted, and for the uncommitted tend to divide between rechargeable lead—acid designs and disposable dry cells. Yet between these two extremes lie areas of application where the advantages of rechargeability with dry-state construction offer significant practical gain.

PERFORMANCE AND TESTING

37494 Mass transfer of dissolved chlorine to a rotating-zinc hemisphere in $ZnCl_2$ solution. Kim, J.T.; Jorne, J. (Wayne State Univ., Detroit). *J. Electrochem. Soc.;* **125**: No. 1, 89-94(Jan 1978).

The chemical reaction of a rotating-zinc hemisphere with dissolved Cl_2 is mass transfer limited. The diffusion coefficients of dissolved Cl_2 in various $ZnCl_2$ aqueous solutions at 25°C were calculated from the weight loss of the rotating Zn hemisphere at various rotational speeds. The Stokes—Einstein equation was confirmed, $(D\mu/T) = 4.42 \times 10^{-10}$ g cm/sec^2 °K, and can be used to estimate diffusion coefficients of total dissolved Cl_2 in various $ZnCl_2$ solutions. The average Cl_2 Stokes radius in $ZnCl_2$ solution is calculated to be 1.64A. The dissolution rate follows the Levich equation for convection diffusion. Surface roughness is of major importance, and the dissolution rate of Zn increases rapidly at moderate Reynolds number. Spiral markings can be observed on the corroding Zn hemisphere due to instability of the three-dimensional boundary layer, as a result of the increasing surface roughness. 5 figures, 4 tables.

37495 Storage batteries: the case and the candidates. Birk, J.R. (Electric Power Research Inst., Palo Alto, CA). pp 12-16 of New options in energy technology. New York; American Institute of Aeronautics and Astronautics, Inc. (1977).

From Conference on new options in energy technology; San Francisco, CA, USA (2 Aug 1977).

See CONF-770824—.

More than fifty years ago, secondary batteries were used advantageously to store and deliver electric energy for electric rail and city emergency power systems. Today, batteries are being considered seriously for storage of off-peak energy because they promise a possibly unique combination of favorable operational characteristics, flexible siting, and environmental compatibility. These prospects have given rise to broad and growing activities in research, development, and engineering of advanced battery concepts and systems for utility energy storage. To date, technical feasibility of several advanced batteries has been demonstrated. The big questions for battery energy storage are whether reliable batteries can be built from cells and batteries can be made economically competitive with other utility option.

37496 State of charge (sealed secondary cells). Norton, B. *New Electron.;* 9: No. 13, 41-42(29 Jun 1976).

Three types of sealed cells are discussed—nickel—cadmium, sealed lead—acid, and cylindrical-electrode lead—acid. These have a capacity ranging from 10 mAh to 10 Ah suitable for the electronics industry.

37497 Power supplies for Army portable electronic equipment. Asquith, P.M. *J. R. Electr. Mech. Eng.;* No. 26, 9-11(Apr 1976).

Some of the factors that affect the selection of a battery power source and some of the battery systems of present interest to the army are discussed.

MATERIALS, COMPONENTS, AND AUXILIARIES

37498 Means for improving contact between Li and the anode current collector. Dey, A.N. (to P. R. Mallory and Co. Inc.). US Patent 4,080,489. 21 Mar 1978. Filed date 8 Mar 1976. 4p.

An alkali metal anode compressed on a smooth metal current collector and adhered to it by means of a metal which spontaneously alloys with the alkali metal at room temperature is described. 1 figure.

37499 Storage battery electrode tubes and method of filling. Brinkmann, J. (to Varta Batterie AG). US Patent 4,039,730. 2 Aug 1977. Priority date 7 Mar 1975, German, Federal Republic of (F.R. Germany). 4p.

Tubular battery electrodes are filled with a mix of lead oxide, sulfuric acid, and water to which electrolyte-resistant fibers have been added. These fibers strengthen the mass and reduce its tendency to escape through the pores of the tube envelope fabric.

37500 Evaluation of porous paper and felt ceramics for electrode separators in high temperature Li—Al/LiCl—KCl/FeS/sub x/ cells. Mathers, J.P.; Olszanski, T.W.; Battles, J.E. (Argonne National Lab., IL). *J. Electrochem. Soc.;* **124**: No. 8, 1149-1154(Aug 1977).

Porous papers and felts fabricated from BN and Y_2O_3 fibers were evaluated as electrode separators for Li—Al/LiCl—KCl/FeS/sub x/ cells. The physical and mechanical properties were determined, and in-cell tests exceeding 1000 h were conducted. The papers and felts had adequate strength and flexibility for cell assembly, and performed well during cell testing. Results from the property measurements are presented, and the performance of these materials in the cell tests is discussed.

37501 Charger for nickel—cadmium cells. Torry, D. *Pract. Electron. (London);* **12**: No. 2, 158(Feb 1976).

An automatic battery charger circuit is described for use in tape recorders and other equipment operating from nickel—cadmium accumulators.

ENERGY MANAGEMENT AND POLICY

REFER ALSO TO CITATION(S) 37244

37502 New England and the energy crisis. Boston; Public Information Center (Oct 1975). 222p. (CONF-7510180—).

From Conference on New England and the energy crisis; Edgartown, MA, USA (Oct 1975).

Each of the seven papers has been individually processed for the Energy Data Base. (DG)

ENERGY ANALYSIS AND MODELING

REFER ALSO TO CITATION(S) 37243, 37541, 37556, 37559, 37563

37503 (DOE/ER—0005/D) **Simple economic model for energy research and supply strategies. Draft.** Canavan, G.H.; Reis, V.H. (Department of Energy, Washington, D.C. (USA)). Apr 1978. 76p. Dep. NTIS, PC A05/MF A01.

This paper derives a simple and transparent model of energy economics and exercises the model to determine energy prices and flows under a reasonable range of resource and policy constraints. The model is based on familiar concepts of the equilibration of demand and supply to determine prices and flows. Demand structures are based on more sophisticated models. Supply structures are a combination of a simple physical model based on Hubbert for the motion of supply curves of depletable resources, exogenous prescription of supplies from those sources for which environmental or social pressures subordinate economics to policy, and highly aggregated models for the penetration of new alternative energy systems as a function of their price, date of availability, and maximum growth rate. The model is calibrated by comparison with a more fundamental model which operates at roughly the same level of source aggregation.

37504 (DOE/PE—0005) **National energy plan: macro-economic effect.** (Executive Office of the President, Washington, D.C. (USA). Energy Policy and Planning). 9 Jun 1977. 22p. NTIS, MF A01.

Portions of document are illegible.

The macroeconomic analyses of the National Energy Plan evaluated its impact on broad economic aggregates such as the gross national product (GNP), unemployment, inflation, and similar measures of economic activity. The micro inputs, including prices of fuels, supplies of fuels, consumption of energy by sector, imports and like variables were primarily obtained from the results of FEA analyses using the PIES model. The macroanalyses made use of standard, econometric forecasting models, principally Data Resources, Inc. and Wharton Economic Forecasting Associates models, as well as other econometric techniques. The most important consideration in such macroanalyses is not the specific model used but the assumptions made about the outcomes of the proposed actions and how they would affect economic decisions and thereby economic activity. The crucial issue is the specification of the microeconomic results (prices, supplies, demands for different fuels and similar variables) and the mechanisms by which they are translated into macroeconomic aggregates. This discussion lists the key decisions that have to be made to go from the microeconomic data to macroeconomic forecasts, discusses the assumptions and specifications that were made about the variables for the administration projections, summarizes the results of the administration's evaluations, and contrasts these projections with estimates by some other forecasts.

37505 (UCRL—52398) **LEM-SEAS compatibility test.** Stern, M.O.; Cooper, R.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 23 Jan 1978. Contract W-7405-ENG-48. 16p. Dep. NTIS, PC A02/MF A01.

A study was performed to test the feasibility and value of linking the Lawrrence Livermore Laboratory Energy Model (LEM)--a version of the Gulf/Stanford Research Institute (SRI) General Equilibrium Model that projects energy supplies with prices--with the Strategic Environmental Assessment System (SEAS) that describes economic activity and environmental impacts. The outputs of a specific LEM operation were manually structured into a SEAS input scenario, and a SEAS operation was conducted. The study demonstrates that the two systems can be linked and are compatible and suggests a plausible future procedure for "embedding" the projected energy world of LEM in the overall economy, as follows: a general economic model, such as SEAS with its associated modules, generates an initial distributed trial demand for energy by sector as input to LEM. LEM projects general equilibrium energy quantities and prices. The general economic model (SEAS), using these as inputs for a second round develops the higher-order "ripples" arising from these prices and quantities and from the investments required to produce them. Certain modifications may have to be made in both systems before such a procedure will produce reliable and interpretable results.

ECONOMICS AND SOCIOLOGY

REFER ALSO TO CITATION(S) 37503, 37504, 37505, 37536, 37556, 37558, 37583, 38705

37506 (CONF-771218—(Summ.)) **Proceedings of the workshop on managing growth in Mercer County, North Dakota.** (Resource Planning Associates, Inc., Cambridge, Mass. (USA)). Feb 1978. Contract EC-77-C-03-1702. 34p. Dep. NTIS, PC A03/MF A01.

From Workshop on managing growth; Bismarck, ND, USA (1 Dec 1977).

The workshop on "Managing Growth in Mercer County" was held on December 1 and 2, 1977, at the Kirkwood Inn in Bismarck, North Dakota. At the opening plenary session, Gerald S. Leighton, Assistant Director of the Division of Buildings and Community Systems, explained the division's role in the development and establishment of the Energy Development Board of Mercer County Dr. Charles F. Metzger, Energy and Natural Resources Coordinator of the North Dakota Governor's Office, discussed the implications of the EDB for Mercer County and the state. Robert Wetzel, Chairman of the EDB, then introduced a slide presentation on the creation of the EDB, its accomplishments, and its future activities. During the afternoon of the first day, the workshop participants separated into three panels for round-table discussions on various aspects of growth-management. Panel 1, "Planning for Growth," concentrated its discussions on specific planning techniques for managing growth in Mercer County and incorporating energy conservation into the community-planning process. Panel II, "Clearing the Way for Growth," discussed solutions to the legal, regulatory, and institutional problems confronting the EDB. Panel III, "Cooperating for Growth," clarified the roles and relationships of the participants in the community development process in Mercer County. The three panel leaders summarized the discussions and recommendations of their panels and presented their summaries at the concluding plenary session of the workshop on the morning of December 2. These presentations are summarized in the report. Other information pertinent to the workshop and transcripts of the major presentations appear in the appendixes following the summaries.

37507 Public utility pricing with stochastic demands: a note. Nguyen, D.T. (Univ. of Lancaster, Eng.). *Appl. Econ.;* **10**: No. 1, 43-47(Mar 1978).

It is shown that if the public utility is required to maintain a very high level of reliability of supply, then demand uncertainty makes very little difference to the utility rates. However, in contrast to earlier studies, capacity has to be a great deal larger than it is in the riskless situation. The analysis draws attention to a plausible explanation for the existence of substantial excess capacity, which seems to be always present in various public utilities. Although there may be little surprise that optimal prices might be significantly affected by the presence of demand uncertainty, the idea has not received much attention in the literature. 5 references.

37508 Financing difficulties of the New England electric utilities. Browne, L. pp 69-112 of New England and the energy crisis. Boston; Public Information Center (Oct 1975).

From Conference on New England and the energy crisis; Edgartown, MA, USA (Oct 1975).

See CONF-7510180—.

In 1974 construction of some 235 electric power plants was postponed or cancelled. In part these deferrals were the result of revised demand projections but, for many utilities, they reflect an inability to generate substantial funds internally or raise outside capital at an acceptable price. The paper examines how New England fared in the recent crisis, focusing on the eight largest investor-owned utilities which account for over 90 percent of the region's generation. Part I discusses the general industry problem of massive capital requirements, dependence upon external funding and the erosion of the ability to attract these investmant funds. Part II considers the New England experience showing how these problems have been intensified by an unusually large construction program and the effects of the energy crisis.

37509 Energy crisis and New England's economy. Eisenmenger, R.W.; Syron, R.F. (Federal Reserve Bank, Boston). pp 41-57 of New England and the energy crisis. Boston; Public Information Center (Oct 1975).

From Conference on New England and the energy crisis; Edgartown, MA, USA (Oct 1975).

See CONF-7510180—.

New England's locational disadvantages and paucity of natural resources have shaped its economy. The realities of the region's situation have forced it to concentrate its manufacturing on skill-intensive products with low energy requirements. The paper analyzes the problem of whether the region's manufacturing base can survive present high energy costs. Included is a brief history of the region's economy which shows that the firms that have survived do not require easy access to national markets, low-cost unskilled labor, low-cost fuel and energy or a mild climate. The region's firms now specialize in the manufacture of such products as computers, jet engines, electronics, specialized machinery, medical instrumentation, specialized industrial fabrics and razor blades. In this way, the region's firms minimize their locational disadvantages and maximize the benefits of a pool of inexpensive high-skilled labor. The paper demonstrates that even though the region's firms have adapted to their harsh environment by specializing in non-energy intensive products and services, the recent rapid escalation in fuel and energy costs has provided a substantial shock. This shock is likely to be felt most by the region's manufacturers. Even though New England manufacturers do not produce energy intensive goods, they still require more than twice as much energy per employee as services. The paper addresses the question of whether the recent increases in energy costs will allow even nonenergy intensive manufacturing industries in New England to survive. An attempt is made to answer this question by quantifying the competitive burden of recent energy price increases on the total costs of New England manufacturing industries.

ENVIRONMENT, HEALTH, AND SAFETY

REFER ALSO TO CITATION(S) 36788, 36794, 36795, 36796, 36797, 36798, 36799, 36800, 36802, 36803, 36807, 36808, 36809, 36810, 36811, 36813, 36814, 36815, 36816, 36817, 36819, 36820, 36821, 36822, 36827, 36828, 36836, 36837, 37230, 37517, 37534, 37548, 37555, 37986, 38075, 38076, 38077, 38078, 38079, 38080, 38096, 38097, 38098, 38099, 38100, 38101, 38102, 38103, 38104, 38120, 38121, 38127, 38128, 38129, 38130, 38131, 38132

37510 (DOE/EDP—0019) **Environmental development plan for Industrial Energy Conservation, 1977.** Sheneman, R.; Moses, D. (Department of Energy, Washington, D.C. (USA)). Mar 1978. 96p. Dep. NTIS, PC A05/MF A01.

This Environmental Development Plan (EDP) identifies the environmental, ecological, social/economic, health, safety and resource issues associated with ERDA research, development, and demonstration conducted in the Division of Industrial Energy Conservation (INDUS) and sets forth environmental RD and D strategies for resolving these issues. The approach taken in this EDP is to examine the environmental issues associated with each individual RD and D project. Emphasis is placed on currently active projects. In the present EDP, it is difficult to detect and programmatic environmental issues that are common to such diverse activities as poultry processing, blast furnace operation, and waste rubber recovery. Six air quality issues, one water quality and waste disposal issue, two occupational safety and health issues, and one public safety and health issue are identified and discussed.

37511 (DOE/EDP—0020) **Environmental development plan for Buildings and Community Systems, 1977.** Hock, J.; Duane, J.; Hagey, G.; Moses, D. (Department of Energy, Washington, D.C. (USA)). Mar 1978. 193p. Dep. NTIS, PC A09/MF A01.

This Environmental Development Plan (EDP) identifies the environmental concerns which include ecological, social/economic, health, safety, and resource impacts associated with the ERDA research, development, and demonstration (RD and D) of buildings and community energy systems and presents an environmental research and development strategy for resolving the concerns. The EDP process provides a framework for: incorporating environmental considerations into agency planning processes at the earliest stages; resolving environmental concerns concurrently with energy technology development; and assuring that adverse environmental effects are mitigated through sound technological design and are at the same level of importance as technological, economic, and institutional issues in decision making. Four technology thrusts covered in this Buildings and Community Systems program are: Architectural and Engineering Systems; Consumer Products and Technology; Urban Waste Technology; and Community Systems.

37512 (DOE/PE—0004) **Air pollution impacts of the oil and gas replacement program in the utility and industrial sectors.** (Executive Office of the President, Washington, D.C. (USA). Energy Policy and Planning; Environmental Protection Agency, Washington, D.C. (USA)). 20 Jun 1977. 55p. Dep. NTIS, PC A04/MF A01.

The oil/gas replacement program requires that new utility plants and large industrial boilers must burn coal or other fuels rather than oil and gas. The NEP contains several provisions to mitigate potential adverse environmental effects from the expanded use of coal, such as the use of best available control technology on all new large facilities. National emissions of industries and utilities are compared for SO_2, particulates, and NO/sub x/ under several scenarios: 1975 actual emissions; a 1985 baseline which would occur with no energy plan; estimate of the impact of the oil/gas replacement (coal) program alone in 1985; and estimate of the impact of the entire President's Program in 1985. The major findings are the oil/gas replacement program causes small increases in national emissions over the 1985 baseline; the national emissions impact of total President's program is not significantly different than the 1985 baseline; emissions in the utility sector decline while they increase in the industrial sector; and regional emissions impacts are insignificant in all regions except the Southwest.

37513 (FWS/OBS—77/50) **Biological services program, fiscal year 1976.** (Fish and Wildlife Service, Washington, D.C. (USA). Office of Biological Services). Sep 1977. 95p. GPO.

Continuing activities are reported on studies seeking to solve ecological problems associated with energy development, other types of land and water developments, and activities of a supporting nature. Specific projects include: coal; power plants; ecological systems and inventory; information transfer; coastal ecosystems and outer Continental Shelf development; and geothermal, oil shale and minerals. (PCS)

37514 Environmental effects of alternative energy developments in the northern Great Plains. Luken, R.A.; Pechan, E.H. *Comput Oper. Res.;* 3: No. 2/3, 259-268(Aug 1976).

A model is used to characterize environmental conditions in the 5-state northern Great Plains region of the U.S. Current conditions resulting from the development of the region's energy resources (primarily coal) are compared, particularly in relation to residuals entitled to the air and water. Various scenarios of energy resource development are investigated. Particulates, sulphur oxides, BOD and suspended solids are considered. Results of the analysis can be used to evaluate development policies.

37515 Energy and the environment: the tradeoffs for New England. MacKenzie, J.J. pp 127-149 of New England and the energy crisis. Boston; Public Information Center (Oct 1975).

From Conference on New England and the energy crisis; Edgartown, MA, USA (Oct 1975).

See CONF-7510180—.

The consumption pattern of energy in the United States, like that of other resources, is determined by many variables. Principal among these are price and convenience. The price of energy has been and continues to be a complicated function of physical availability, international politics, government price regulation, import controls, technological innovation, and environmental regulation, to name but a few of the more important variables. Contrary to popular belief, however, environmental regulations have never been the primary reason for either the growth or decline of any major source. The consumption of coal, the dirtiest of fossil fuels, hit its peak, at 77 percent of total energy supply, in 1910. Its relative use has declined since that time because of the availability and convenience of liquid and gaseous fuels—not because of air pollution regulations. Similarly, the consumption of natural gas, the cleanest of our fuels, grew dramatically after World War II because of its convenience and low price, the latter largely the result of Federal price controls. Recent environmental laws have of course made it more costly to burn dirtier fuels. But within the last five years sulfur oxide scrubbers have been developed to meet EPA emission restructions. Moreover, a whole range of alternative (if not new) technologies promises to allow the burning of coal essentially without air pollution. Environmental regulations, therefore, can and will affect the pattern of

energy use primarily through the pricing adjustments necessary to produce "clean" energy as measured by the various standards of environmental quality. One of the major goals of the environmental movement is to include within the price of energy all of the social, environmental and public health costs and risks incurred in its production and consumption.

ENERGY RESOURCES

37516 (CONF-770440—) **Energy and mineral resource recovery.** (American Nuclear Society, Hinsdale, Ill.). 1977. 828p. Dep. NTIS, PC A99/MF A01.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

Individual papers were indexed separately for the data base.

37517 (LBL—6872) **Water requirements for future energy production in California.** Sathaye, J.A.; Ritschard, R.L. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). May 1977. Contract W-7405-ENG-48. 62p. Dep. NTIS, PC A04/MF A01.

This assessment estimates the impact of future national energy development on water resources. Energy development would include various types of electric power plants, production of synthetic fuels, coal and uranium mining, oil and gas extraction, and other conversion processes. The Energy Analysis Program at LBL has conducted this analysis for its assigned region, the states of California and Nevada. The objective of this study is to determine water requirements of energy technologies and their implications, with emphasis on emerging technologies for aggregated subareas (ASA) in California. The first phase of this study provides energy-supply projections and corresponding demands for water resources as perceived by regional and state groups responsible for or involved in energy planning in California and Nevada. The second phase of the study is designed to calculate the water requirements for the levels of energy development in California as specified by a Department of Energy scenario for the year 2000 and by utility projections as reported by the Federal Power Commission for 1985. The implications of these water requirements on competing water users are explored briefly. 24 references.

37518 (NP—23187) **Nation's renewable resources: an assessment, 1975. Forest resource report No. 21.** (Department of Agriculture, Washington, D.C. (USA)). Jun 1977. 259p. GPO.

In response to past increases in population, economic activity, and income, the demand for nearly all products of forest and range lands, and the associated inland waters, has risen rapidly. The growth has been especially fast for some forms of outdoor recreation. This study provides an analysis of the present situation and the outlook for outdoor recreation and wilderness, wildlife and fish, forest-range grazing, timber, and water. It includes statistical data on the ownership, condition, and productivity of the U.S.'s 16 billion acres of forest and range lands and associated inland waters; recent changes in forest, range, and inland water resources; trends in the consumption and prices of major products; the prospective demand, supply, and price outlook to 2020; and opportunities for increasing supplies of products and improving productivity. Data are also included on international trade in forest and range products and the forest resources of important trading countries. The final chapter investigates the scientific information and data needs to conduct the inventories. (MCW)

37519 (USGS-CIRC—765) **Estimated use of water in the United States in 1975.** Murray, C.R.; Reeves, E.B. (Geological Survey, Washington, D.C. (USA)). 1977. 45p. Survey, Interior Dept., Arlington, VA.

Estimates of water use in the United States in 1975 indicate that an average of about 420 bgd (billion gallons per day) or about 1,900 gallons per capita per day, was withdrawn for the four principal off-channel uses which are: public supply (for domestic, commercial, and industrial uses); rural (domestic and livestock); irrigation; and self-supplied industrial (including thermoelectric power). In 1975, withdrawals for these uses exceeded by 11.5 percent the 370 bgd estimated for 1970. Increases in the various categories of off-channel water use since 1970 were: approximately 12.8 percent for self-supplied industry (mainly in electric-utility thermoelectric plants), 7.6 percent for public supplies, 10.0 percent for rural supplies, and 10.8 percent for irrigation. Industrial water withdrawals included 70 bgd of saline water, a 30 percent increase in 5 years. The fifth principal withdrawal use, hydroelectric power (an in-channel use), amounted to 3,300 bgd, a 5-year increase of 20.7 percent. In computing total withdrawals, recycling within a plant (reuse) is not counted, but withdrawal of the same water by a downstream user (cumulative withdrawals) is counted. The quantity of freshwater consumed, that is, water made unavailable for further possible withdrawal because of evaporation, incorporation in crops and manufactured products, and other causes, was estimated to average 95 bgd for 1975, an increase of about 10 percent since 1970. Estimates of water withdrawn from the principal sources indicated that 82 bgd came from fresh ground water, 1 bgd came from saline ground water, 260 bgd came from fresh surface water, 69 bgd came from saline surface water, and 0.5 bgd was reclaimed sewage.

37520 **Minerals availability: trends and problems.** Crowson, P.; Jackson, G.; Corlett, D. (Rio Tinto-Zinc Corp. Ltd., London). *Eng. Process Econ.;* **3**: No. 1, 3-9(Jan 1978).

The cost pressures on mineral-producing industries and on manufacturing are analyzed. The production costs of comparable-sized manufacturing plants tend to be similar, each mine is unique. Production costs are determined largely by geological geographical circumstances over which the operating company has little control. Whereas manufacturing concerns can, within broad limits, choose their plant location, mining companies must perforce go where the ore is. The grade, chemical composition, physical characteristics, and the size of the ore body, the degree and type of processing required, the types and extent of by-product credits, and the location and consequent infrastructure needs all greatly influence costs. Some mines can make handsome profits even while others of a similar size are facing closure through uneconomic prices. Capital requirements, environmental problems, and energy requirements are compared. The effects of two new technological developments--to find ways of mining or treating minerals that have in the past not been considered as ore because of accessibility or chemical properties and to improve on the processes used on existing ores--are examined. Specifically cited are the mining and processing of sea bed manganese nodule and the direct reduction for the production of iron and steel. (MCW)

RESEARCH AND DEVELOPMENT

REFER ALSO TO CITATION(S) 37533, 37534

37521 **Roles of aerospace organizations in energy development, or can aerospace success bring success in energy.** Finger, H.B. (General Electric Center for Energy Systems, Washington, DC). pp vp of New options in energy technology. New York; American Institute of Aeronautics and Astronautics, Inc. (1977).

From Conference on new options in energy technology; San Francisco, CA, USA (2 Aug 1977).

See CONF-770824—.

To those who would question the gravity of our energy situation, Dr. Finger points out that no nation can be so heavily dependent on foreign sources of oil without losing some of its independence of action--and without being continually under a threat to its national security. He cites the already substantial contribution of aerospace companies to U.S. R and D activities, including those of NASA's laboratories and field centers involved in a limited way in ERDA's program management. While the aerospace involvement is great and reflects the industry's imagination, conceptualization, and equipment-development, Dr. Finger states that most of the advanced concepts are not in the mainstream of the nation's present energy system; further, these concepts may not be cost- or performance-competitive in the marketplace in at least the critical next two decades. Therefore, he sees no significant role for the aerospace industry until after this time. Only those companies, such as General Electric, which are part of a diversified business organization (with already established business relations and markets) can make the necessary technology transfer to help on a current basis. Dr. Finger warns against viewing (or organizing) the ERDA R and D mission from our experience with NASA and DOD--the government is not the ultimate consumer--but fears the energy R and D structure is proceeding largely in the same patterns. He also warns against short cuts or cheap buys in the R and D process--premature full-system tests lengthen rather than shorten development schedules.

NUCLEAR ENERGY

REFER ALSO TO CITATION(S) 36904, 36990, 37308, 37544

37522 **Uranium supply and demand.** London; Mining Journal Books (1977). vpp.

Separate papers were abstracted individually for the data base.

37523 **Nonproliferation: a long-term strategy.** Nye, J.S. *Foreign Aff.;* **56**: No. 3, 601-623(Apr 1978).

Major elements of President Carter's non-proliferation policy are analyzed in terms of their possible long-term effects. The policy's goal is seen as one which better addresses the realities of regional instabilities and the balance of world power. The three-decade

chronology of nuclear policy is traced to underline the advantages of slowing commercial reprocessing until safer technologies and better international institutions are developed. Six elements of the strategy are identified: (1) safeguards, (2) restraints, (3) incentives, (4) building consensus, (5) domestic nuclear policy, and (6) measures to affect motivation. Challenges, both domestic and international, have developed to the policy, but none of the available alternatives is felt to promote the needed reexamination and redirection as well.

37524 Great nuclear debate: German—American disagreements. Kaiser, K. (Univ., Cologne). *Foreign Policy;* No. 30, 83-110(Spr 1978).

The post-war international consensus on nuclear nonproliferation has been eroding because of the debate over actions taken by some countries and because of the U.S. response with a unilateral change in nuclear policy. The chronology of developments is traced, noting that the 1973—74 oil crisis, India's nuclear explosion in 1974, and the exchange of Brazilian uranium for German technology all had a major role in the policy controversy. New nonproliferation proposals by the Carter administration, by precipitating debate between those wanting tighter export controls and those with nuclear commercial interests, also introduced several foreign-relations problems because of the emphasis on international agreements and a technological approach. The U.S. is credited with taking a constructive step to correct the inadequacies of the present policies and exerting pressure for global involvement in reassessing the rules on armaments and proliferation. Significant U.S. leadership could also take the form of lower energy consumption.

37525 Energy future of West Germany. Fells, I. (Univ. of Newcastle-upon-Tyne, Eng.). *Energy World;* No. 43, 4-7(Dec 1977).

The nuclear power controversy in W. Germany casts doubt that the target of 30,000 MW nuclear capacity by 1985 can be met. The similarities of the environmental and the political situation to that in North America are pointed out. The role of coal in making up the shortfall is described briefly. Nuclear research is still dominant, however, and the future of electricity generation is still pinned firmly on nuclear power. Research is being done on the fast breeder and the high-temperature thorium reactor. The Germans emphasize the free market and the coupling of GDP growth and energy demand. Reasons are given for the importance of the 30,000 MW nuclear generating capacity by 1985. The dangers of the present anti-nuclear mood are pointed out. (DLC)

37526 Nuclear anxieties and their impact on nuclear power programs. Mizumachi, K. pp 34-41 of Uranium supply and demand. London; Mining Journal Books (1977).

From 2. symposium on uranium supply and demand; London, UK (22 Jun 1977).

See CONF-7706120—.

The impact on Japanese nuclear power programmes of nonproliferation control measures and restrictions on the trade in uranium ores is discussed. Relevant information is supplied as tables, entitled: official Japanese energy supply/demand programme, 1973 to 85; two independent forecasts of Japanese energy prospects, 1973 to 2000; long-range energy supply/demand programme for Japan, 1975 to 1990. The tables include nuclear power as well as fossil fuel and other sources of energy.

37527 Co-operative ventures with developing countries: an assessment of recent experience. Donndorf, H.M. pp 177-188 of Uranium supply and demand. London; Mining Journal Books (1977).

From 2. symposium on uranium supply and demand; London, UK (22 Jun 1977).

See CONF-7706120—.

The various forms of cooperation are described and assessed under the following headings: concession, joint venture agreement, service contract, intergovernmental agreements. The economic, technical and political aspects of cooperation are discussed. It is concluded that the governments in both producer and consumer countries should act in close cooperation with the private mining company, to get the most satisfactory results.

TRANSPORT AND STORAGE

REFER ALSO TO CITATION(S) 37487, 37490, 37495, 37605

WASTE HEAT UTILIZATION

REFER ALSO TO CITATION(S) 37575

37528 (COO—2947-3) **System analysis, design, and proof-of-concept experiment of a total energy system. Final report, May 15, 1976—June 13, 1977.** Lehrfeld, D. (Philips Labs., Briarcliff Manor, N.Y. (USA)). Aug 1977. Contract EY-76-C-02-2947. 189p. Dep. NTIS, PC A09/MF A01.

Philips Laboratories investigated the application of Stirling-cycle prime movers to total-energy power generation systems. Electrical, heating, and cooling demand profiles for a typical residential complex, hospital, and office building were studied, and alternative Stirling total-energy systems were conceptualized for each site. These were analyzed in detail and contrasted with purchased-power systems for these sites to determine fuel-energy savings and investment attractiveness. The residential complex and hospital would be excellent candidates for total energy systems, and prime movers in the 1000-kW output range would be required. Stirling engines with so large an output have not been built to date, although there would be no fundamental technical barrier to prevent this. However, careful consideration must be given to the following technological decision areas before arriving at a final design, if its potential is to be realized: engine configuration, hot-side heat exchange interface, engine control system, internal gas seals, and advanced coal combustion technology. The principle advantage of a Stirling prime mover in this application, in view of national concern over present and future dependence on oil, is that it could utilize low-grade liquid fuels and coal.

37529 (EPRI-EM—718-SR) **Dual-energy-use-system workshop summary.** (Electric Power Research Inst., Palo Alto, Calif. (USA)). Mar 1978. 93p. Dep. NTIS, PC A05/MF A01.

Results of EPRI's Dual-Energy-Use-Systems (DEUS) Workshop held September 19-23, 1977, in Yarmouth, Maine, are presented. Participants from the electric utility industry, industrial and other consumer experts, government representatives, academicians, and equipment manufacturers met to discuss and evaluate the various options for using thermal and electric energy produced from a common source. Work sessions based on formal presentations and group discussion resulted in a list of 32 R, D, and D projects of potential interest to state and Federal program managers as well as to utility personnel. A resource document, which should be useful to utilities in the process of developing programs related to DEUS, was compiled from the workshop presentations. The application areas reviewed were: district heating, co-generation, use of power plant reject heat, total energy applications, and emerging technologies with potential for simultaneous production of heat and power. Each type of application was covered in some detail. This report presents an overview of the workshop sessions, lists the research projects identified, and contains abstracts of the 35 papers presented.

37530 (HCP/M60172—01/1) **Potential for cogeneration development in six major industries by 1985. Executive summary.** (Resource Planning Associates, Inc., Cambridge, Mass. (USA)). Dec 1977. 62p. Dep. NTIS, PC A04/MF A01.

In estimating industrial co-generation development potential both without and with government action, the authors concentrate on those six industries that consume a significant amount of electricity and process heat: chemicals, petroleum refining, pulp and paper, steel, food processing, and textiles. Further, the study focuses on process steam topping applications because the initial analysis of industrial co-generation potential indicates that 60 to 70 percent of the potential development is in these applications. Finally, because a large proportion of energy savings was estimated to be associated with applications of greater than 5 MW of electrical power, the study focuses on applications above this size. The analysis of process steam co-generation in the six focus industries indicates that government action can stimulate almost as much process steam co-generation by 1985 as the baseline development that would normally occur, resulting in gross energy savings of 80 to 300 trillion Btu per year depending on the range of Federal economic and regulatory measures implemented.

37531 (SAND—77-0029, pp 9.1-9.16) **Total energy user point of view.** DeMaso, J. Jan 1977.

From 2. symposium on solar total energy; Albuquerque, NM, USA (25 Jan 1977).

In Proceedings of the solar total energy symposium.

Considerations necessary for operation of a total energy plant with the highest practical degree of quality and reliability are presented. (MHR)

37532 (TID—28393) **Department of Energy programs and objectives: fluid waste heat recovery and utilization.** (Washington Scientific Marketing, Inc., D.C. (USA)). Feb 1978. Contract W-31-109-ENG-38. 36p. Dep. NTIS, PC A03/MF A01.

The primary objective of the Division of Industrial Energy Conservation is to improve technology that will make industry and agriculture more energy-efficient. The Division is working to remove technological and economic barriers to enhance industrial implementation of energy-efficient processes and technology. The Division has formulated five subprograms to carry out the Division's goals. These are waste energy reduction; alternate materials utiliza-

tion; advanced cogeneration;industrial process efficiency, and agricultural and food process efficiency;

CONSERVATION

REFER ALSO TO CITATION(S) 37511, 37532, 37545, 37559, 37561, 37575

37533 (DOE/EDP—0017) **Environmental development plan for Conservation Research and Technology Program, 1977.** Moses, D.; Shapiro, M. (Department of Energy, Washington, D.C. (USA)). Mar 1978. 77p. Dep. NTIS, PC A05/MF A01.

The Conservation Research and Technology (CONRT) EDP covers the environmental concerns related to CONRT technology R and D, whereas the end-use division EDPs cover the environmental concerns of system demonstrations and applications. After chapters on environmental strategy needs, objectives of this program, and technique for screening applicable projects, Chapter 4 characterizes middle-grade heat utilization, alternative fuels, 4.8-MW(e) fuel-cell power plant development, and first-generation systems development. Scientific desciplines that were investigated in Chapter 5 to point out environmental concerns were organic Rankine bottoming cycle, biphase system, resource assessment, wood-fired and waste-fired boilers, and fuel cells. The strategy for resolving environmental concerns is discussed in the final chapter. (MCW)

37534 (DOE/EDP—0018) **Environmental development plan for the Division of Transportation Energy Conservation, 1977.** Maxfield, D.; Moses, D. (Department of Energy, Washington, D.C. (USA)). Mar 1978. 172p. Dep. NTIS, PC A08/MF A01.

This programmatic plan identifies the ecosystem, resource, physical environment, health safety, and socio-economic issues associated with the DOE research, development, demonstration, and assessment of thirteen transportation technologies. These include the Stirling and gas turbine engines, constant speed accessory drive system, bottoming cycle for heavy duty trucks, continuously variable transmission, new hydrocarbons (brood-cut petroleum fuels), alcohol and synthetic fuels, hydrogen, electric and hybrid vehicles, pipeline bottoming cycle, and stratified-charge concept. The EDP presents a research and assessment strategy for resolving any potentially adverse environmental issues stemming from these technologies. The EDP process provides a framework for: incorporating environmental considerations into agency planning processes at the earliest stages; resolving environmental issues concurrently with energy technology development; and assuring that adverse environmental effects are mitigated through sound technological design and are at the same level of importance as technological, fiscal, and institutional issues in decision-making. Information contained in this EDP constitutes an inventory of the status of environmental problems and a plan for resolving these problems.

37535 (HCP/M51891—01) **Effect of energy conservation guidelines on comfort, acceptability, and health. Final report.** Gagge, A.P.; Nevins, R.G. (John B. Pierce Foundation of Connecticut, Inc., New Haven (USA)). Mar 1976. 217p. Dep. NTIS, MF A01.

Portions of document are illegible.

A requirement for a research program relating proposed energy-use strategies and guidelines for energy-conservation practices on human comfort, acceptability, performance, and health became clearly recognized during a Conference on Energy Conservation Research held by the National Science Foundation on 18—20 February 1974 at Airlie House, Warrenton, Virginia. Proposals to FEA for further research, as a result of the conference, were made and are discussed here, namely: Task I: Conduct laboratory tests on response of representative adult subjects to thermal environments specified by FEA energy guidelines 78 to 80°, relative humidities 40, 60, and 80%; Task II: Conduct a field survey of an operating office building (GSA Building, Federal Plaza, New York City) using the FEA guidelines to determine occupant reaction and performance, as well as the nature of the indoor environment; Task III: Use the National Bureau of Standards Simulation Programs (NBSLN and PIHI) in determining the magnitude, duration, and frequency of indoor environmental conditions under these guidelines (80 to 82°F settings with no humidity control and no reheat) for typical office buildings or apartments in different climatic regions in the USA; Task IV: Initiate laboratory studies along the same lines as Task I to evaluate the thermal environment specified by the FEA Winter Guidelines of 65 to 68°F at 20 and 40% RH; Task V: Repeat the survey of the GSA Building (Task II) during the winter months. Four special technical reports are included. (MCW)

37536 (RLO—2332-1) **Minimizing consumption of exhaustible energy resources through community planning and design. Final report.** (Alaska State Div. of Energy and Power Development, Anchorage (USA)). Oct 1977. Contract EY-76-C-06-2332. 149p. Dep. NTIS, PC A07/MF A01.

This document represents the final report of a study performed by the State of Alaska and numerous consultants on energy conservation techniques which could be applied to the planning, design, and construction of a new community in the northern climates. The State of Alaska intends to relocate its Capital from Juneau to a site north of Anchorage. This study focused on the minimizing of exhaustible energy resources through planning and design of this new capital city. It was found that the major determinants to energy consumption in a community are the land-use patterns, which affect intracity transportation and utilities distribution, and the built density of the individual homes and buildings which affects heat losses. Configuration of the community also affects the savings that may be realized through the use of district heating and other energy-conserving technologies.

37537 (SAN—1692-1) **Research, development, and demonstration for energy conservation: preliminary identification of opportunities in iron and steelmaking.** (Little (Arthur D.), Inc., Cambridge, Mass. (USA)). Jan 1978. Contract EC-77-C-03-1692. 140p. Dep. NTIS, PC A07/MF A01.

The Federal Government has initiated, expanded, and is accelerating a cost-shaped program with the iron and steel industry to develop innovative, cost-effective programs for new energy-saving technologies. The purpose of this document is to identify opportunities for research and development in the iron and steel industry, giving due consideration to the many barriers that impede the implementation of new technology. These technology sectors also reflect the following three fundamental criteria that DOE has formulated to guide the selection of projects for consideration in this program: the project must have the potential to save energy; the project must be considered cost-effective when fully developed; when fully developed, the project must be considered reliable and have no negative effect on capacity. Concepts considered for commercial development have been selected because of their significant potential for conserving energy and/or critical fuel forms and on the assumption that they would involve: preparation of proposals by or in conjunction with companies associated with the steel industry, to ensure the practicality of the concept in a steelmaking environment; cost sharing with companies associated with the steel industry; and demonstration of technology that would provide an option for the iron and steel industry to be less dependent on natural gas and distillate fuels. In addition, the program is aimed at stabilizing employment and increasing U.S. strategic security.

37538 (TID—28388) **Practical materials for teaching energy management. A resource file.** (Federal Energy Administration, Washington, D.C. (USA)). 1977. 194p. Dep. NTIS, PC A09/MF A01.

This resource file was prepared by the Federal Energy Management Program (FEMP) to help with the complex and time-consuming process of identifying, selecting, and obtaining materials for promoting energy-conservation skills. Although it has been developed primarily for the Federal sector, the file may be useful to anyone with responsibility for reducing energy use. Managers and staff development coordinators, educators, and extension agents who are concerned with improving energy conservation skills should find the file to be of value. Librarians, technical information specialists, and others who are called upon for referral to practical energy conservation can use this resource file to identify relevant publications. Section II includes comprehensive descriptions of such items as operations and maintenance manuals, life-cycle costing handbooks, films on fuel-saving driving techniques, and courses devoted entirely to weatherization. Section III describes supplementary resources such as technical studies of energy conservation options, pamphlets containing simple tips, and supportive documents such as the ASHRAE Standard 90-75. These publications can be used to add technical and theoretical depth to a presentation or a class. Some of them, such as studies of attitudes toward energy conservation, may be of use in planning an educational program that will overcome many of the misperceptions that exist. Energy conservation in buildings and fixed facilities, transportation systems, and all other applications are included. (MCW)

37539 **NASA energy conservation program.** Gaffney, G.P. (NASA Headquarters, Washington, DC). pp vp of New options in energy technology. New York; American Institute of Aeronautics and Astronautics, Inc. (1977).

From Conference on new options in energy technology; San Francisco, CA, USA (2 Aug 1977).

See CONF-770824—.

Around 1970, NASA established a program to identify large energy-consuming facilities at the NASA field installations. Many of the field installations were equipped with large, energy-intensive research and test equipment. Even in the days of "cheap energy", this consumption represented a significant cost. The program was aimed at not only identifying those facilities, but to conserve the consumption of utility resources as a matter of sound managerial practice. With the establishment of the President's energy reduction goal in 1973, NASA was able to quickly establish a formal program

to significantly reduce energy consumption without affecting basic research activities. A key element in successfully initiating this program was an existing reporting system upon which more comprehensive data could be readily compiled and management direction could be sensibly based.

SUPPLY, DEMAND, AND FORECASTING

REFER ALSO TO CITATION(S) 36704, 37503, 37505, 37558

37540 (EPRI-EA—621-SR(Vol.1)) **DEMAND 77: EPRI annual energy forecasts and consumption model. Volume 1. Forecasts and general description of the model.** Williams, L.J.; Boyd, J.W.; Crow, R.T. (Electric Power Research Inst., Palo Alto, Calif. (USA)). Mar 1978. 77p. Dep. NTIS, PC A05/MF A01.

This report presents forecasts of end-use consumption of electricity, petroleum, natural gas, and coal for the years 1980 to 2000. The forecasts are based on an econometric model whose equations represent energy consumption of each form of energy in each end-use sector. The forecasts are based on a forecast of long-run economic growth coupled with three scenarios concerning energy prices and conservation policy. Each of the scenarios was coupled with two scenarios concerning natural gas availability, one in which natural gas supplies are restricted at the assumed price and the second in which natural gas is freely available at the assumed price. The scenarios were: (1) a baseline scenario, which assumed that the most likely energy prices would prevail and that no significant new conservation policies would be adopted; (2) a high-electricity-consumption scenario, with low oil prices and minimal obstacles to the use of coal and nuclear energy for electricity generation: and (3) an energy-conservation scenario, which embodied the proposals in President Carter's National Energy Plan. Forecasts are presented for each of the sectors and for each of the forms of energy by five-year periods. The structure of the econometric model is described along with plans for further development.

37541 (IIASA-RR—76-19) **WELMM approach to energy strategies and options.** Grenon, M.; Lapillonne, B. (International Inst. for Applied Systems Analysis, Laxenburg (Austria)). Dec 1976. 44p. Dep. NTIS (US Sales Only), PC A03/MF A01.

The development of energy resources requires more and more natural or human resources--on the one hand because of the difficulty of "harvesting" primary energy resources, and on the other because of the complexity of the sequence of processes necessary to convert these primary resources into useful resources for an economy (final energy). In this context the WELMM approach has been designed to evaluate the resource requirements for the development of energy resources. WELMM focuses mainly on five limited resources: water, energy, land, materials, and manpower. The WELMM evaluation is implemented at the level of the major facilities concerned in the harvesting and conversion of primary energy resources into final resources. All the WELMM data are stored in three different data bases (Resource Data Base, Component Data Base, and Facility Data Base). They are meant to be used to enlarge and complete the traditional economic comparison of energy processes, energy strategies, or energy options.

37542 (LA—6689-MS) **Preliminary optimization model for assessment of energy development in the Rocky Mountain region.** Hinman, G.; Kolstad, C.; Morris, G.; Palmer, R.; Pendley, R. (Los Alamos Scientific Lab., N.Mex. (USA)). Mar 1978. Contract W-7405-ENG-36. 61p. Dep. NTIS, PC A04/MF A01.

The dominant feature of most forecasts for Rocky Mountain regional energy development is that the region will serve as a major supplier of energy to meet demands originating primarily outside the region. In examining the implications and tradeoffs associated with regional energy development, it is insufficient merely to consider demand for resources from the region as a whole--a mechanism is required for allocating that demand within the region. A linear programming model has been developed to determine the most economically efficient way (subject to environmental and other constraints) in which extraction, conversion, and transportation of energy forms can take place to satisfy these demands. This report describes the model and discusses a preliminary specification in some detail, including a discussion of input data and some characteristic outputs. It also discusses drawbacks in the preliminary version and plans for future model refinements.

37543 (LA-UR—78-706) **Contribution of chemistry to energy.** Cox, K.E. (Los Alamos Scientific Lab., N.Mex. (USA)). 1978. Contract W-7405-ENG-36. 23p. (CONF-780305—15). Dep. NTIS, PC A02/MF A01.

From Division of fuel chemistry meeting; Anaheim, CA, USA (12 Mar 1978).

Chemistry has contributed in many ways to energy production and conversion in the fossil fuel era. The challenges facing chemists and chemical engineers as we look forward to the 21st Century are addressed. This paper discusses some of the means that can be employed to meet this challenge both in the near-term and long-term, particularly alternate fuels from coal and solar energy storage and conversion. A leading candidate for an energy supply medium is hydrogen; implementing this concept may well be the greatest challenge faced by chemists as we leave the age of fossil fuels and enter the era of renewable energy. (DLC)

37544 (NP—23123) **IGT predicts moderate increase in U.S. energy consumption in 1978.** Parent, J.D.; Linden, H.R. (Institute of Gas Technology, Chicago, Ill. (USA)). 20 Dec 1977. 19p. of Gas Technology, Chicago, IL.

A detailed energy supply and demand estimate for 1978 is presented, along with the original and revised estimates for 1977. The revised estimate of energy consumption in 1977 of 77.94 quads represents a 4.9% increase over the 1976 figure, and the predicted 1978 consumption of 80.46 quads is 3.2% greater than that. These figures compare to an expected increase in GNP of 4.9% in 1977, and 4.5% in 1978. On this basis, the ratio of energy consumption to GNP will continue its recent downward trend from 62.4 thousand Btu/$ (1972) in 1970 to 58.3 thousand Btu/$(1972) in 1976 and 1977 and 57.6 thousand Btu/$(1972) in 1978. This represents a close approach to the minimum value of 57.5 thousand Btu/$(1972) which occurred in 1966. The energy consumption per capita will continue to increase from the 1970-76 range of 328 to 355 million Btu per capita to 359.5 in 1977 and to 368.3 in 1978. Net oil imports are expected to rise from the 1976 level of 2588 million bbl (7.09 million bb/day) to 3125 in 1977 (8.56 million bbl/day) and to 3180 (8.71 million bbl/day) in 1978. Of these quantities, 250 million bbl are estimated to go into stocks in 1977 and 200 million bbl in 1978. Thus, this study indicates that imports will level off in 1978 rather than decline as some others have envisaged. Reasons for this include less than hoped-for contributions of nuclear energy, decreased hydroelectricity because of the drought, displacement of natural gas by oil, and delays in reaching full capacity in the Alyeska oil pipeline.

37545 **Alternatives to oil and gas through energy management.** Belding, J.A. (Energy Research and Development Administration, Washington, DC). pp 4-11 of New options in energy technology. New York; American Institute of Aeronautics and Astronautics, Inc. (1977).

From Conference on new options in energy technology; San Francisco, CA, USA (2 Aug 1977).

See CONF-770824—.

This nation is facing a critical shortage of oil and natural gas resources. Although projections of recoverable resources vary considerably, all agree that the rate of recovery will decrease, while consumption will increase. As a result, a shortfall will occur. This can be made up by importing oil and gas, but this solution is temporary, and is counter to stated national policy. One of the most attractive solutions is the replacement of oil and natural gas with alternate fuels. The primary candidates are coal, nuclear, and solar. To facilitate a transition to these fuels and at the same time prevent a critical shortfall in the short term, we must conserve currently wasted energy. This is the only energy management strategy solution that can reduce the need for oil and gas.

37546 **International oil outlook: a scenario approach.** Ritchie, J.D. pp 17-33 of New England and the energy crisis. Boston; Public Information Center (Oct 1975).

From Conference on New England and the energy crisis; Edgartown, MA, USA (Oct 1975).

See CONF-7510180—.

Four alternate scenarios, each a description of what the world might be like and consistent within itself, are presented to illustrate possible futures depending on available energy sources, government policies, economic growth, and conservation. It is concluded that primary energy growth will come from coal and nuclear energy; solar and fusion energy are possible long-term solutions but they will make no substantial contribution in the present century. (JSR)

37547 **Environmental challenges of Alaskan mineral development.** Hayes, E.T. *UMR J.;* No. 2, 27-29(Jun 1971).

To meet the challenges and to develop Alaska as a source of mineral and fuel resources that are essential to all of us, we must conduct the research and planning necessary to see that the environment is not abused. We cannot allow ourselves the luxury of thinking that we alone know what is best for Alaska. We must strive for cooperation—cooperation between government and industry; between Federal and State governments; between the doer and the dreamer; and between the engineer and the ecologist. Remember, the quality of what we do today will determine the quality of Alaska in the future—and the future is as near as tomorrow.

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 36743, 37521, 37523, 37545

37548 National energy planning and environmental responsibility. Seamans, R.C. Jr.; Liverman, J.L.; Ordway, F.I. (Energy Research and Development Administration, Washington, DC). *Environ. Aff.;* **6**: No. 3, 283-300(1978).

The United States can move towards a state of energy self-sufficiency only by pursuing both an aggressive conservation policy and a vigorous energy research, development, and demonstration (R, D, and D) program. The Energy Research and Development Administration (ERDA) was established in early 1975 to direct the nation towards such a beneficial pattern of energy use and production. This article discusses some of the major elements of ERDA's national energy R, D, and D plan, and emphasizes the design of energy R, D, and D alternatives to minimize adverse environmental effects. In October, 1977, all ERDA functions were absorbed by the Department of Energy. Today ERDA's energy R, D, and D initiatives are being continued within this new organizational framework. After givig a background to the crisis and the National Energy Plan, greater energy-efficiency opportunities are discussed for three sectors: transportation, residential/commercial, and industrial. Then production efforts for the principal sources of energy are reviewed under the following topics: coal; uranium; enhanced recovery of oil and gas; solar heating and cooling; geothermal energy; synthetic fuels; and essentially inexhaustible energy sources for the long term. 51 references and notes.

37549 Importance of a New England energy policy. Salmon, T.P. pp 221-225 of New England and the energy crisis. Boston; Public Information Center (Oct 1975).

From Conference on New England and the energy crisis; Edgartown, MA, USA (Oct 1975).

See CONF-7510180—.

National and regional energy policy considerations are enumerated as they apply to New England. Emphasis is placed on the lack of endogenous resources in New England and on the economic impact of New England's vulnerability to higher energy costs. (DG)

FOSSIL FUELS

REFER ALSO TO CITATION(S) 37544

COAL

REFER ALSO TO CITATION(S) 36595, 36722, 36739, 36743, 37512

37550 (HCP/B60573—01) Utility analysis of coal transportation availability. Final report. (Energy Resources Co., Inc., Cambridge, Mass. (USA)). 15 Sep 1976. 160p. Dep. NTIS, PC A08/MF A01.

Under the Energy Supply and Environmental Coordination Act of 1974, the Federal Energy Administration was directed to serve, to certain electric utility and industrial power plants, prohibition orders restricting them from burning petroleum products and/or natural gas as their primary energy sources and, thus, necessitating conversion to coal. This study seeks to determine if the transportation systems and facilities servicing first-round ESECA-candidate electric utility power plants are adequate to support a finding of transportation availability for those plants. The study identifies, characterizes, and documents transportation systems availability for each ESECA plant with respect to the following areas: (1) trunk lines from coal-supply region to demand region, including mode, ownership, and capacity; (2) spur lines from trunk lines to plants, including mode, ownership, capacity, and structural integrity; (3) mine-site loading and plant-unloading facilities, including ownership, capacity, and needed construction or refurbishment; and (4) economically feasible alternative systems for purposes of fallback routes if the primary route should become inadequate. The modes of transport considered included railroad rolling stock (general, unit, and integral trains), barges, and trucks. A time frame of 1976 to 1985 (inclusive) was used.

37551 Gasoline, petrochemicals, and energy in the future. Andrew, S.P.S. (I.C.I. Agricultural Div., Billingham, Eng.). *Eng. Process Econ.;* **3**: No. 1, 11-16(Jan 1978).

A techno-commercial assessment of the possible sources of petrochemicals and energy for land and air transport in the future, based on currently known chemistry, suggests that synthetic gasoline produced from cheap coal in very large multi-fuel producing plants will become the commodity source of petrochemicals when natural liquid and gaseous hydrocarbon sources run short.

PETROLEUM

REFER ALSO TO CITATION(S) 36595, 36749, 36772, 36785, 36849, 36850, 36854

37552 Effect of vertical integration on risk in the petroleum industry. Mead, D.E. (Federal Energy Administration, Washington, DC). *Q. Rev. Econ. Bus.;* **18**: No. 1, 63-90(Spr 1978).

This article discusses some of the important theoretical considerations affecting the influence of vertical integration on risk and offers some new empirical evidence on this subject. The results indicate that refiner integration into crude oil production tends to reduce risk over the entire range of integration levels experienced by oil companies in the sample. These results differ from those of Edward J. Mitchell, who concluded that integration tended to reduce risk only up to the integration level of 50 percent crude self-sufficiency and tended to increase risk at higher integration levels. To the extent that risk increases capital costs, the results presented here indicate that any law requiring oil firms to divest themselves of either their crude oil production or their refining assets may tend to increase the costs of producing refined petroleum products, other factors held constant. 9 references.

37553 Joint ventures in Middle East oil, 1957—1975. Stevens, P.J. Beirut; Middle East Economic Consultants (1976). 215p. .

Three types of joint venture have operated in the Middle East for the purpose of oil production: (1) operators of the "old style" concessions who have dominated oil production in the area until now; (2) the contract agreement in which a foreign company acts as a contractor on behalf of the national oil company of the host country; this first appeared in the area in 1966; and (3) the equity joint venture in which one or more foreign companies and the national oil company of a host country share the equity of the operating company. These equity ventures are of two types: the partially integrated venture which is intended to be a profit-making company whose function is to find, produce, and market oil for its own account; and the operating agency which is intended to be a non-profit making agency concerned only with finding and producing oil as the agent for the partners. The equity joint venture is the main subject of this book. The area in which these joint ventures are examined includes Egypt, Iran, Saudi Arabia, Kuwait, Iraq, and Jordan. Since Egypt and Iran are the only countries to have actually operated joint ventures, their experiences provide the bulk of the factual material used. Joint ventures are examined from two points of view. First, the factors which have affected the development of joint ventures are considered. These include the trends which have developed in the industry as a whole, the objectives of both parties to the ventures, and the limitations to the achievement of these objectives. Second the way in which the development of joint ventures has in turn affected the oil industry is examined, including its effect upon the operational aspects of the industry, and upon relations between the foreign oil companies and the host countries.

NATURAL GAS

REFER ALSO TO CITATION(S) 36749, 36772, 36863, 36864

37554 End-user pricing of natural gas. Cicchetti, C.J. (Wisconsin Public Service Commission, Green Bay); Wiener, D. *Public Util. Fortn.;* **101**: No. 6, 11-15(16 Mar 1978).

The paper focuses on the alternative end-use tariff structures for natural gas. Emphasis is on marginal-cost pricing. First, there is a brief description of traditional natural gas pricing structures. While there is considerable variability between utilities, all do contain some common features. The second section contains a discussion of these tariff structures. Following are discussed the purposes of marginal-cost pricing, the advantages of pricing signals, and residual, but other equally important advantages. The final section deals with some of the problems with marginal-cost pricing, specifically the questions of excess revenues and fairness.

HYDROGEN AND SYNTHETIC FUELS

REFER ALSO TO CITATION(S) 37030, 37039, 37551

ELECTRIC POWER

REFER ALSO TO CITATION(S) 37100, 37490, 37544

37555 (DOE/EDP—0016) Environmental development plan for Electric Energy Systems Program, 1977. Hagey, G.; Krezanosky, L.T. (Department of Energy, Washington, D.C. (USA)). Mar 1978. 103p. Dep. NTIS, PC A06/MF A01.

This Environmental Development Plan (EDP) identifies and examines the physical, ecological, health, safety and socio-economic environment concerns associated with the research, development and demonstration of ERDA's Electric Energy Systems (EES) Program, the requirements and actions needed to resolve these concerns, and a time-phased action plan for the evaluation and mitigation of environmental impacts. This plan provides a framework for: incorporating environmental considerations into the planning process at the earliest stage; resolving environmental concerns concurrently with the technology development; and ensuring that adverse environmental effects are mitigated through sound technological design. This Environmental Development Plan addresses the Electric Energy System Program which includes the following technologies: overhead AC/DC Transmission;underground transmission (including superconducting transmission); generation; storage applications; systems development and forecasting studies; and systems control studies.

37556 (EPRI-EA—517-SR) **Survey of econometric models of the supply and cost structure of electricity.** Cowing, T.G.; Smith, V.K. (State Univ. of New York, Binghamton (USA)). Mar 1978. 247p. Dep. NTIS, PC A11/MF A01.

This report describes empirical studies of economic aspects of the electric power industry. It includes a general description of the industry, a discussion of the coneept of aggregation, and summaries of studies of generation, transmission, and distribution. In addition, the report discusses the economic theory of production technology, including derived demands, technical change and duality, and the economic characteristics of the process technologies of generation, transmission, and distribution. Finally, industry-supply models and informal-price models are reviewed and critiqued. The Appendix contains annotated bibliographies of relevant PhD dissertations. 124 references.

37557 (HCP/R2642—1) **Evaluation of a linear programming approach for estimating the market penetration of peaking/intermediate electric generation technologies.** Park, W.; Gsellman, L.; Morris, J. (Mitre Corp., McLean, Va. (USA). METREK Div.). Jan 1978. Contract EA-77-C-01-2642. 48p. (MTR—7706). Dep. NTIS, PC A03/MF A01.

This paper presents a linear programming approach, developed for ERDA, for estimating the future purchase of new peaking and intermediate electric generation technologies. In 1976, ERDA contracted with MITRE/METREK to perform a benefit/cost evaluation for the acceleration of selected ERDA electric energy research that had potential near-term benefits, that is, benefits accruing prior to 1985. In early 1977, this work was interrupted by the ERDA Market Oriented Program Planning Study (MOPPS). As part of METREK's support to MOPPS, the methodology developed for the near-term study was expanded. The expanded model was used for MOPPS penetration estimates and also as the basis for the near-term study which was then continued and completed in late 1977. During this latter implementation period, the MOPPS market penetration model came under close scrutiny both at ERDA and at METREK. Weaknesses were identified and alternatives suggested to improve the model performance, resulting in the development of the LP alternative. Section 2.0 of this paper presents the formulation of the linear program. Section 3.0 describes the computer software developed and utilized implement the program. Test runs conducted to compare the LP formulation with the MOPPS methodology are presented and evaluated in Sectin 4.0. Suggested extensions to the LP methodology are presented in Section 5.0. Finally, conclusions drawn from analysis of the test results are summarized in Section 6.0.

37558 Measurement of own-price effects on the household demand for electricity. Ruffell, R.J. (Univ. of Stirling, Eng.). *Appl. Econ.;* **10**: No. 1, 21-30(Mar 1978).

The effects of two errors on the estimated own-price coefficient are assessed for the U.S. and Great Britain markets, with application to any fuel market. Where electricity consumers face a block tariff, omission of the intramarginal prices from the individual's demand function when aggregating over consumers will often cause negligible bias in the coefficient of marginal price in the aggregate demand function for electricity. Bias can arise if either the marginal price variable in the aggregate function is not correctly defined as a function of all the marginal rates faced by individual consumers, the value of which depends on mean consumption, the distribution of consumption about this mean and the tariff, or if this dependence is ignored. If the demand equation contains the stock of appliances and an explanatory variable, then the own-price coefficient does not generally measure simply the effect of a change in price on the utilization of a given stock of appliances. 9 references.

ELECTRIC POWER GENERATION

REFER ALSO TO CITATION(S) 37565, 37570

37559 (NP—21756) **Survey of combined-cycle power generation: state-of-the-art. Report No. 14.** (New Zealand Energy Research and Development Committee, Auckland). Oct 1976. 48p. Dep. NTIS (US Sales Only), PC A03/MF A01.

This review shows that where gas is available, recuperative combined-cycle plant has many advantages over conventional steam plant. Their relevance to New Zealand's electricity requirements was investigated. Combined-cycle power generation is of relatively recent origin and offers advantages in overall efficiency, fuel consumption, capital cost, and environmental impact. Reservations about their use arise mainly from limited operational experience, the requirement for clean fuels for the gas turbine component, and considerations of reliability. Investigations carried out for the study include: types of combined cycle plant; economics; availability of various plants; a review of overseas operating experience; reliability; technical background; and environmental aspects. In New Zealand's present energy situation with growing emphasis on the use of natural gas for electricity generation and the desirability of reducing dependence on oil, the assessment of a new and more efficient generating technology assumes an economic significance which was not present two or three years ago. New Zealand's energy economics may be profoundly influenced by the combined-cycle generating plant. A combined-cycle power station combines gas turbine and conventional steam turbine power generation, with both types of turbine driving electricity generators. The two turbine functions are linked by passing the hot exhaust gases from the gas turbine into a boiler where steam is raised to drive the steam turbine. This report concentrates on the "recuperative" combined cycle plant, which recovers the heat in the gas turbine exhaust in a boiler, where steam is raised to drive the steam turbine. (MCW)

ELECTRIC POWER TRANSMISSION AND DISTRIBUTION

37560 Guidelines for inter-utility energy exchange agreements. Spafford, G. (Unies Ltd., Winnipeg, Can.); Haberman, L.P.; Young, D.A. *Can. Electr. Eng. J.;* **2**: No. 3, 2-4(Jul 1977).

Complete flexibility in the exchange of energy between electrical utilities within a defined geographic region has many advantages. These include (a) savings in fuel by maximizing the utilization of hydroelectric capability through the integrated operation of thermal, electric and hydroelectric components, (b) minimization of capital investment by providing capacity expansion to meet load growth using the overall optimum sequence of new source development, (c) reduction of capacity requirements through diversity in the time of peak load between electrical utilities, (d) improvements in system reliability, (e) gains in overall capability due to hydrological diversity in hydroelectric components of the joint system. It can be accepted that, within the defined geographic region, the cost of meeting electrical demand can be minimized by the optimization of operation and capacity expansion of the electrical supply system. However, the achievement of this goal is severely hampered by the existence of several autonomous electrical utilities within the defined regions. The geographic boundaries of these utilities are politically constrained and are generally unrelated to either location of electrical demand centers or electrical energy sources. As a result, formulae developed to achieve an equitable distribution of costs and benefits between electric utilities are complex. The factors involved in establishing such formulae on the basis of optimum regional operation and capacity expansion are presented. The requirements and difficulties involved in reaching satisfactory inter-utility agreements are discussed, and basic approaches to formulation of agreements are presented.

CONSUMPTION AND UTILIZATION

REFER ALSO TO CITATION(S) 37505, 37536, 37537, 37540

37561 (COO—1340-56) **Effects of atmospheric variability on energy utilization and conservation. Final report, 1 November 1976—31 October 1977.** Reiter, E.R.; Dreiseitl, E.; Johnson, G.R.; Leong, H.H.; Macdonald, B.C.; Somervell, W.L. Jr.; Starr, A.M.; Timbre, K.O. (Colorado State Univ., Fort Collins (USA). Dept. of Atmospheric Science). Feb 1978. Contract EY-76-S-02-1340. 89p. Dep. NTIS, PC A05/MF A01.

A space-heating energy-consumption model for Greeley, Colorado for the winter of 1976-77 was within 98.9 percent of actual natural gas consumption for that city. Modeling of Cheyenne, Wyoming, including the testing of a new statistical scheme to develop the building census required by the energy consumption model, has progressed to the point where reliable natural gas consumption estimates can be made with the model for that community. A detailed study of temperature and surface wind patterns in and near the city of Greeley, Colorado revealed that, at times, an urban heat island effect is present, in spite of the relatively small size of that town. Various feedback mechanisms between the oceans and the

atmosphere were examined. Several of these mechanisms appear to be the cause of the interannual variability of the atmosphere's general circulation and of climatic changes on a time scale of several tens of years. A recent cooling trend in the North Pacific north of 40°N, and sea-surface temperature fluctuations with an irregular periodicity of 2 to 4 years superimposed upon this trend were studied. To advance regional long-range forecasting skills January temperature anomalies over the eastern United States were correlated with flow patterns over the U.S. and Canada.

37562 (DOE/EIA—0031/2) **Federal Energy Data System (FEDS): Statistical summary.** Fuller, R.F. (Department of Energy, Washington, D.C. (USA). Energy Information Administration). Feb 1978. 891p. Dep. NTIS, PC A99/MF A01.

The Federal Energy Data System (FEDS) has data on annual energy consumption from 1960 through 1975, categorized by fuel, sector, and geographic area. The major fuels considered are coal, natural gas, motor gasoline, jet fuel, distillate, residual, electricity, and hydro and nuclear power. Data on petrochemical feedstocks, other petroleum products and other raw materials are also included. The sectors considered are residential, commercial, industrial, transportation, and electric utilities. The data are at the State level, with census division and national totals included. The FEDS data base also includes selected macroeconomic and demographic data.

37563 (SAN—1314-1) **Energy in agriculture: on modeling energy inputs in AGRIMOD. Final report, August 1976—June 1977.** Levis, A.H.; Ducot, E.R.; Wall, K.D.; Sidenblad, K.M.; Levis, I.S. (Systems Control, Inc., Palo Alto, Calif. (USA)). Aug 1977. Contract EY-76-C-03-1314. 220p. Dep. NTIS, PC A10/MF A01.

AGRIMOD is a dynamic simulation model of the U.S. food production system designed for the analysis of (a) the implications of alternative national policies on the food supply, (b) the effects of possible natural resource and energy constraints on food supply and prices, (c) the impacts of policies on imports, exports, and reserves, and (d) the effects of technological change. The model consists of seventeen submodels fully integrated through material and information flows into four sectors and three markets. This report contains a description of AGRIMOD's submodels with particular emphasis on the modifications and enhancements made to increase the model's capabilities for carrying out analyses of the impacts of alternative energy conservation strategies on agricultural and food production. Also included is a baseline scenario for the period 1975 to 1990 with several energy alternatives. The effects of increasing energy costs on the agricultural sector and on food prices are analyzed using the simulation results from the baseline scenario and its variants. 60 references.

UNCONVENTIONAL SOURCES AND POWER GENERATION

37564 **New options in energy technology.** New York; American Institute of Aeronautics and Astronautics, Inc. (1977). 149p. (CONF-770824—).

From Conference on new options in energy technology; San Francisco, CA, USA (2 Aug 1977).

A separate abstract was prepared for each of 22 of the 24 articles; one article was processed previously. All abstracts will appear in Energy Research Abstracts (ERA); 13 were selected for Energy Abstracts for Policy Analysis (EAPA).

SOLAR

REFER ALSO TO CITATION(S) 37059, 37100, 37101, 37102, 37103, 37104, 37105, 37106, 37107, 37109, 37110, 37216, 37543

GEOTHERMAL

REFER ALSO TO CITATION(S) 37148, 37175, 37176, 37177, 37178, 37179, 37180, 37181, 37185

OTHER

REFER ALSO TO CITATION(S) 37518, 37565, 37569, 37570

ENERGY CONVERSION

REFER ALSO TO CITATION(S) 37564

MHD GENERATORS

37565 **Utility views of MHD power generation.** Shih, C.H.; Guha, M.K. (American Electric Power Service Corp., New York). pp 33-40 of New options in energy technology. New York; American Institute of Aeronautics and Astronautics, Inc. (1977).

From Conference on new options in energy technology; San Francisco, CA, USA (2 Aug 1977).

See CONF-770824—.

One of the national goals of energy independence is to make use of abundant domestic coal resources with higher efficiency. The open-cycle MHD power generation has the potential to fulfill this goal and has a good technical prospect. AEP recently completed an assessment of the state-of-the-art of this technology, and is convinced that a systematic development with a coordinated effort is necessary for the MHD process to be successful. Further, AEP feels that the national program should be actively and jointly supported by the developers and utilities. As a coal-based utility company, AEP's views and understanding of the MHD technology are described.

DESIGN AND DEVELOPMENT

37566 (FE—1542-2) **Report on the MHD performance demonstration experiment, for the period May 1, 1975—September 30, 1976.** Schmidt, H.J.; Garrison, G.W.; Welch, N.E. (Arnold Engineering Development Center, Arnold Air Force Station, Tenn. (USA)). Jul 1977. Contract EX-76-A-01-1542. 94p. Dep. NTIS, PC A05/MF A01.

The Arnold Engineering Development Center (AEDC) has been under contract since December 1973 to modify existing equipment and to design, fabricate, and install new hardware to perform an MHD Performance Demonstration Experiment. The objective of the experiment is to demonstrate that a generator simulating a commercial-sized device can convert 16 to 18 percent of the available thermal energy into electrical power. The design, fabrication, and installation of hardware for the test during the period from May 1, 1975 to September 30, 1976 are described. The renovation of existing equipment and the design of major hardware components were completed prior to May 1975; thus the major effort during the past sixteen months has been the procurement, fabrication, and installation of hardware. In particular, the LORHO magnet was removed and the bottom steel machined and reassembled to form the base for the new dual mode magnet. The aluminum for the magnet force containment structure was procured and a contract awarded for the machining of the structure. The copper for the coils was procured and the contract for forming the coils was awarded. A considerable effort was expended in developing manufacturing quality control procedures and in perfecting brazing techniques for joining the copper bars. The channel outer structure, electrodes, fasteners, and graphite caps, as well as 60 percent of the pegboards, were fabricated.

PERFORMANCE AND TESTING

REFER ALSO TO CITATION(S) 37566

MATERIALS, COMPONENTS, AND AUXILIARIES

37567 (FE—1542-3) **Final engineering report on the dual mode magnet for the high performance demonstration experiment.** Averill, R.J.; Hay, R.D.; Langton, W.G.; Rapperport, E.J. (Magnetic Engineering Associates, Inc., Cambridge, Mass. (USA)). Jul 1977. Contract EX-76-A-01-1542. 185p. Dep. NTIS, PC A09/MF A01.

The magnet for the MHD High Performance Demonstration Experiment is designed to provide (at 27 MW and 16,000 amp) a peak field of 6 T when pulsed from 77°K (LN_2) and 3.5 T when operated continuously water-cooled. The magnet bore is 0.89 m wide by 0.71 m high at the entrance, 1.4 m wide by 1.17 m high at the exit, and the poles are 7.1 m long. The total length of the magnet (not including the sideplates of the force containment structure) is 9.16 m. The magnet saddle coils consist of 720 turns of copper hollow conductor, 2.5 cm square with a 0.66 cm diam cooling passage. The copper hollow conductor is electrically insulated with 0.018 cm thick half-lapped B-stage epoxy impregnated tape and then 0.010 cm thick Mylar taped half-lapped to provide 0.056 cm of insulation on each turn. The coils are constructed in eighteen "pancakes" of 40 turns in two layers. The large Lorentz forces generated at the peak of the 6 T pulse are contained by an aluminum force containment structure. The large aluminum components are fitted together using interlocking tongue grooves and keyways to contain the large forces. The force containment structure and coils are surrounded by styrofoam insulation (ranging from 7.62 cm to 15.24 cm thick) on the outside and a 2.54 cm thick vacuum insulating box inside the bore. The steel return frame is located outside the thermal insulation.

THERMIONIC CONVERTERS

DESIGN AND DEVELOPMENT

37568 (COO—3056-30) **NASA/DOE advanced thermionic technology program. Progress report No. 28.** (Thermo Electron Corp., Waltham, Mass. (USA)). Oct 1977. Contract EY-76-C-02-3056. 21p. Dep. NTIS, PC A02/MF A01.

Surface studies of thermionic emitters and collectors in the surface characterization chamber are described. Plasma studies including converter theory, experimental plasma analyses, and enhanced mode conversion experiments are discussed. Progress in thermionic converter development, the component hardware program, and the combustion-heated thermionic device program are outlined. (WHK)

FUEL CELLS

DESIGN AND DEVELOPMENT

37569 **Improvement in phosphoric acid fuel cell powerplant technology.** Handley, L.M.; Grevstad, P.E.; McVay, D.R. (United Technologies Corp., South Windsor, CT). pp 41-50 of New options in energy technology. New York; American Institute of Aeronautics and Astronautics, Inc. (1977).

From Conference on new options in energy technology; San Francisco, CA, USA (2 Aug 1977).

See CONF-770824—.

An ERDA sponsored program has resulted in improvement in durability and cost of the phosphoric acid fuel cell power section and the fuel processor in a large, efficient first-generation electric utility powerplant. The program has served as a technology bridge between the 1.0-megawatt pilot plant tested at United's facility in early 1977 and the 4.8-megawatt demonstrator scheduled for delivery to a utility site in 1978. These powerplants are steps leading to commercial availability of the 2m-megawatt FCG-1 for use in electric utility systems.

37570 **Economic assessment of the utilization of fuel cells in electric utility systems.** Wood, W. (Public Service Electric and Gas Co., Newark, NJ); Bhavaraju, M.P.; Yatcko, P.; Fickett, A.P. pp 51-61 of New options in energy technology. New York; American Institute of Aeronautics and Astronautics, Inc. (1977).

From Conference on new options in energy technology; San Francisco, CA, USA (2 Aug 1977).

See CONF-770824—.

The long-range economic benefits of first-generation and advanced fuel cells in the future generation-capacity plans of a representative electric utility system are evaluated. The benefits of fuel cells' unique characteristics are separately quantified and the relationships between market penetration, fuel price, and capital cost are analyzed utilizing reliability, production cost, and optimum-generation-mix methods commonly used for generation planning in utilities. The results indicate that the first-generation fuel cells are attractive for intermediate duty and second generation for both intermediate- and base-load duty if the projected goals of capital cost and heat rate can be met.

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 37569

ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION

REFER ALSO TO CITATION(S) 37539

BUILDINGS

REFER ALSO TO CITATION(S) 37511, 37536, 37538, 37558, 37562

37571 **Heat engines and heat pumps.** Cheng, C.Y.; Cheng, S.W. US Patent 4,079,596. 21 Mar 1978. Filed date 24 Mar 1976. 14p.

The invention described introduces a heat engine, or a heat pump, in which the working medium used is subjected alternatively to solidification and melting operations. A working medium so used is referred to as an S/L type working medium. In a new heat engine, an S/L type working medium is subjected to cyclic operations, each cycle comprises of a high temperature melting step conducted under a first pressure, and a low temperature solidification step conducted under a second pressure. In a new heat pump, each cycle comprises of a high temperature solidification step conducted under a first pressure and a low temperature melting step conducted under a second pressure. When a nonaqueous medium is used, the first pressure and the second pressure are a relatively high pressure and a relatively low pressure, respectively. When an aqueous medium is used the two pressures are a relatively low pressure and a relatively high pressure, respectively. It is noted that the operation of a heat pump is the reverse operation of a heat engine.

37572 **Heating system.** Trump, G.S. US Patent 4,079,778. 21 Mar 1978. Filed date 30 Sep 1975. 12p.

The invention described includes a heating system for use with a primary source of heat, such as a gas hot air furnace, or the like. A first conduit formed with perforations conveys hot exhaust gases generated by the furnace to a flue. A second conduit carrying a fluid is coiled about the first conduit in close proximity so as to permit a transfer to heat to the fluid from exhaust gases escaping from the perforations and contacting the second conduit. A third conduit houses the first and second conduits and conveys exhaust gases that have escaped through the perforations to the flue. Sleeve means intermediate to the first and second conduits control the rate of the heat transfer.

37573 **Energetic-exergetic analysis of the behavior of the vapors compression heat pump cycle, working with NH_3 and R-11.** Radcenco, V.; Dobrovicescu, A. *Rev. Roum. Sci. Tech., Ser. Electrotech. Energ.;* **22**: No. 4, 605-620(1977). (In Russian).

A discussion is given of a computer program for the comparative analysis of the behavior of the vapor compression heat pump cycle based on the state equations of the NH_3 and R-11 vapors. The energetic-exergetic balance is suggested having in view the relation between economy and exergetic efficiency.

RESIDENTIAL BUILDINGS

REFER ALSO TO CITATION(S) 37117, 37528

37574 (AED-Conf—76-407-008) **Space heating in urban centers with gas-fired heat pumps.** Rostek, H.A. (Ruhrgas A.G., Essen (Germany, F.R.)). 1976. 17p. (CONF-7609113—4). Dep. NTIS, PC A02/MF A01.

From Congress on rational energy utilities in urban systems with specialized exhibition at the German Industrial Exhibition; Berlin, F.R. Germany (18 Sep 1976).

The role of natural gas for the supply of urban centers is discussed and some basic remarks on heat pumps, e.g., the special features and the advantages of gas-fired heat pumps, are presented. Energy savings achieved with any type of heat pump can be improved upon even if the heat pump is gas-fired. In this type of heat pump, a significant energy contribution to the heat pump process is made in the form of engine heat with a high temperature level. Its special importance for the gas economy is due to the fact that a greater number of customers can be supplied without increasing the transportation capacity of existing gas networks.

37575 (ORNL/CON—21) **Development and testing of a single-plate and a two-plate ice-maker heat pump.** Fischer, H.C. (Oak Ridge National Lab., Tenn. (USA)). Apr 1978. Contract W-7405-ENG-26. 51p. Dep. NTIS, PC A04/MF A01.

The step-by-step development of a working ice-maker heat pump is outlined for both a single-plate machine and a full-size two-plate machine built and tested at Oak Ridge National Laboratory. Test results reveal that a coefficient of performance (COP) of about 2.94 can be easily achieved with currently available components. By optimizing the design it is felt that a COP of 3.5 can be attained. Freezing cycle times of 12 to 20 min appear to be optimum from both capacity and COP standpoints. Harvesting times in excess of 40 sec need not be tolerated in a good design. A "no thermodynamic penalty" harvesting system that utilizes the enthalpy of the condensed liquid refrigerant to provide the heat to harvest the ice from the plate was developed and tested. The heat pump is intended for use in the Annual Cycle Energy System (ACES).

37576 **Small diesels for domestic power supply.** Koefoed, E. *Energy Int.;* **14**: No. 8, 26-27(Aug 1977).

Studies have shown that the utilization of small diesel package units for heat and power production, either wholly or partially, could provide worthwhile economic benefits in many communities, but it requires a close understanding between the private producer and the public utility if it is to succeed. By application of diesel engines for domestic heating purposes, the heat transmitted to the cooling water and the heat in the exhaust gas is used. The heat in the cooling water can be fully utilized, along with approximately 70 percent of the heat in the exhaust gas. The diesel engine can be connected to an electrical generator or a heat pump, or perhaps both.

OFFICE BUILDINGS

REFER ALSO TO CITATION(S) 37528, 37535

SCHOOL, MUNICIPAL AND OTHER PUBLIC BUILDINGS

REFER ALSO TO CITATION(S) 37243, 37535

COMMERCIAL AND INDUSTRIAL BUILDINGS

REFER ALSO TO CITATION(S) 37528

37577 Build underground and conserve energy: fact or fiction. McCreath, D.R.; Mitchell, D.E. (Acres Consulting Services Ltd., Niagara Falls, Ontario). *Eng. J. (Montreal);* **6**: No. 2, 14-16(Apr 1978).

The facts available from existing usage of underground space for industrial/commercial facilities indicate that energy savings of 50% are commonly achieved, and savings of up to 90% have been achieved in some instances, compared to equivalent aboveground facilities. These figures deal only with direct energy savings, whereas a complete picture must include life-cycle energy requirements including construction, maintenance and transportation. Consideration of the full picture may alter its perspective in specific cases, although preliminary indications are that the underground picture does look attractive when life-cycle analysis is undertaken. The fact is that it has been done, it is being done, and it does conserve energy. In Canada, although the underground shopping malls of Montreal and Toronto have shown the benefits of underground usage, the concept has not received wide acceptance, or even serious consideration, in the aggregate mining and industrial areas.

37578 Energy management for commercial buildings and cooling storage. Dubin, F. (Dubin-Bloom Associates, New York); Rosenfeld, A.; Simonson, T. pp 1-3 of New options in energy technology. New York; American Institute of Aeronautics and Astronautics, Inc. (1977).

From Conference on new options in energy technology; San Francisco, CA, USA (2 Aug 1977).

See CONF-770824—.

The feasibility and cost of installing chilled water storage in new buildings so that electric chillers can be turned off during times of peak power demand are discussed. To replace a 100-ton chiller for 5 h, the cost of thermal storage may be as low as $250/ton, about half the cost of new gas turbines and distribution systems to supply the peak power. Cost of storage is presented as a function of chiller size.

TRANSPORTATION

REFER ALSO TO CITATION(S) 37534, 37538, 37562

RAILWAY

REFER ALSO TO CITATION(S) 37536, 37550

37579 Simulation studies of energy saving with chopper control on the Jubilee line. Mellitt, B.; Goodman, C.J.; Arthurton, R.I.M. (Univ. of Birmingham, Eng.). *Proc. Inst. Electr. Eng. (London);* **125**: No. 4, 304-310(Apr 1978).

The energy-consumption studies undertaken for the operation of rapid-transit services on London Transport's new Jubilee line are described. The object of the studies was to provide comparative figures for the energy consumption of a chopper-controlled fleet and a conventionally equipped rheostatically-controlled fleet. The work was undertaken using a digital computer simulator in which train movement and power-network calculations are interdependent. This approach permits the evaluation of system constraints when regenerative braking is used in conjunction with the usual, plain diode, noninverting type of substation. Detailed figures are provided for various services operating on a short 5 km isolated power block section of the line and also for peak and off-peak services on the whole line. Sensitivity experiments on this 5 km section demonstrate the dependence of energy reduction on the opportunities to transfer energy between trains, on the line voltage limit and on the traction equipment specification. For whole line operation, at peak and off-peak headways, the energy savings are 15 percent and 9 percent, respectively. These figures reflect the use of a low characteristic traction motor and the moderate proportion of braking energy actually available for potential regeneration (52 percent of total braking effort for an average loaded train).

LAND AND ROADWAY

REFER ALSO TO CITATION(S) 37536, 37550

SEA AND WATER

REFER ALSO TO CITATION(S) 37550

PIPELINE

37580 First Coberrow compressor set completed. *Diesel Eng.;* **73**: No. 795, 241-242, 245(Win 1977).

A description is given of Rolls-Royce/Cooper Bessemer modular gas compressor sets with a total capacity of 570 MW (ISO) for six transmission stations along a Soviet natural gas pipeline. The 42 gas compressor sets will be installed at six of the 13 transmission stations along a 960 km natural gas pipeline leading from the West Siberian gas fields in the Tyumen region of the USSR to Chelyabinsk for onward transmission to the major cities of Western USSR and for export to Comecon member countries and Western Europe. Of 1420 mm diameter, the pipeline has a design capacity of 110×10^6 m^3/day at 75 bar design pressure, with five sets operating at each station. Each of the six transmission stations will be equipped with seven identical compressor sets, each incorporating a Rolls-Royce Avon 1533-76G aero-derivative gas generator with a Cooper—Bessemer RT48 two-stage power turbine directly coupled to a Cooper—Bessemer RF2BB30 two-stage centrifugal compressor.

INDUSTRY AND AGRICULTURE

REFER ALSO TO CITATION(S) 37510, 37536, 37538, 37562

37581 (NP—21760) Energy use in the kilning, drying, and heat curing industries. Report No. 11. Noble, J.; Clarke, R.B.; Naylor, T. (New Zealand Energy Research and Development Committee, Auckland). Sep 1976. 34p. Dep. NTIS (US Sales Only), PC A03/MF A01.

A study was made to analyze existing energy use and to establish opportunities for energy conservation in New Zealand industries which use significant amounts of heat in process kilns or dryers and which have not been the subject of previous similar studies. The industries studied included: cement, concrete products, clay products, glass, breweries, pasteboard, asphalt, and heat-cured sheet metal painting. Energy usage data for each industry were obtained, compiled, and analyzed. Opportunities for energy conservation in each industry are specified. Yearly energy savings of 2.5 to 25% per industry are projected. (LCL)

37582 Energy conservation in the design of new plants. Lorimer, G.A. (Shawinigan Engineering Co. Ltd., Montreal). *Eng. J. (Montreal);* **6**: No. 2, 5-12(Apr 1978).

From Industrial energy conservation seminar; Ottawa Conference Center, Ontario, Canada (Nov 1977).

Ideas for energy conservation in new plant design are discussed, including design criteria, retrofitting, waste heat recovery and plant construction. The importance of the subject will continue to increase as plants built for a 3-to-5 year pay-back period seem to be operating 10 to 20 or more years, and the efficiency, or inefficiency built into them initially can have a good or bad effect long after the pay-back period, despite the very marked gains that can be obtained through retrofit energy conservation projects. The planning phase of many new projects has been extended by many months, or even years from what it once was, to allow time for governmental approval, environmental considerations, financial arrangements, market surveys. Therefore the designer will have more time to make comparative studies to serve the best interests of energy conservation.

37583 Energy optimization in industrial processes. I. Investments and exploitation costs. le Goff, P. *Rev. Gen. Therm.;* **42**: No. 193, 9-26(Jan 1978). (In French).

A mathematical model is proposed for the cost of an industrial process as a function of the energy degraded by the operation and the costs of construction materials, money and time. Minimization of investments or of total cost involves calculating the two corresponding values of degraded energy as a function of various technical and economical parameters. This model gives general expressions for energy savings reduction of total cost of an extra investment and its pay-out time. Some variations related to these quantities, which only depend on physical/chemical parameters of the system, lead to statements of scientific economic theory.

37584 Direct firing applications. Thome, W.L. pp 11p, Paper 19 of Aluminum industry energy conservation workshop. New York; Aluminum Association, Inc. (1976).

From Aluminum industry energy conservation workshop; Cleveland, OH, USA (26 May 1976).

See CONF-7605154—.

The advantages of and equipment for direct firing of metallurgical furnaces are discussed. The advantages include fuel savings,

reduced load heating time, multiple fuel capabilities, safety, and lower initial cost as compared with radiant tube fired furnaces. Direct firing with oil and gas has been applied to heating billets, ingots, scrap and in continuous strip annealing and solution heat treating. It appears that the future will see most of these processes being conducted in direct fired or electrically heated furnaces. The degree of conversion will certainly be limited only by metallurgical aspects. (LCL)

37585 Open fired ingot heating furnace. Toups, K.J. pp 4p, Paper 21 of Aluminum industry energy conservation workshop. New York; Aluminum Association, Inc. (1976).

From Aluminum industry energy conservation workshop; Cleveland, OH, USA (26 May 1976).

See CONF-7605154—.

Experience with the application of open fired heating furnaces to ingot soaking is related. Six radiant tube furnaces were converted to open fired units which could burn natural gas or fuel oil. No detrimental effects to the ingots was found. Heat-up time was reduced. A natural gas savings of 10.5 percent was achieved. Maintenance downtime was reduced. The overall performance was highly satisfactory. (LCL)

37586 Direct fired forge stock heater. Volkmar, R.D. (Kaiser Aluminum and Chemical Corp., Pleasanton, CA). pp 5p, Paper 22 of Aluminum industry energy conservation workshop. New York; Aluminum Association, Inc. (1976).

From Aluminum industry energy conservation workshop; Cleveland, OH, USA (26 May 1976).

See CONF-7605154—.

Experience in converting 5 gas-fired radiant tube furnaces used for preheating aluminum prior to forging to direct fired furnaces capable of firing with gas or fuel oil is discussed. The advantages found included a gas consumption reduction of 29.5 percent, shorter heating time required, and fuel versatility. More forging furnace conversions to direct firing are planned. (LCL)

ENERGY SOURCES

REFER ALSO TO CITATION(S) 36781

MATERIALS

REFER ALSO TO CITATION(S) 37537

EQUIPMENT AND PROCESSES

REFER ALSO TO CITATION(S) 37242

37587 Energy requirements in electrolytic winning and refining of metals. Ettel, V.A. (Inco Metals Co., Mississauga, Ont.). *CIM Bull.;* **70**: No. 783, 179-187(Jul 1977).

Current practices in electrolytic winning and refining of copper, nickel and zinc are reviewed from the point of view of their respective energy requirements. The electrical energy requirements of these processes are broken down into the individual components, which belong to two basic categories: (a) thermodynamic energy requirements (Δ G of the desired reaction); and (b) energy losses (anode and cathode polarizations, ohmic drops in the electrolyte and in the cell hardware, energy losses due to unwanted side reactions and electrical shorts). The individual energy components are separately examined for each electrolytic process and the potential for energy saving in these processes is discussed. It is shown that many potential energy-saving measures are uneconomical at the present time, as they increase over-all operating costs. The discussion is focused on those approaches which hold most promise for the future.

37588 Direct-fired soaking pits. Cronk, O.L. (Kaiser Aluminum and Chemical Corp., Pleasanton, CA). pp 7p, Paper 20 of Aluminum industry energy conservation workshop. New York; Aluminum Association, Inc. (1976).

From Aluminum industry energy conservation workshop; Cleveland, OH, USA (26 May 1976).

See CONF-7605154—.

Some of the information and experience developed through the operation of an aluminum ingot pre-heat furnace that was designed specifically as a direct natural gas fired facility are presented. For comparison, data from older, radiant tube type furnaces are included. The direct-fired approach provides significant improvements in furnace performance as well as efficiency of fuel utilization. Both of these factors are extremely important in the continuing efforts toward doing the metal industry's job better and doing it with less fuel.

WASTE HEAT RECOVERY AND UTILIZATION

REFER ALSO TO CITATION(S) 36780, 37265, 37365, 37530, 37532, 37572

37589 (COO—2916-3) **Energy conservation in fruit dehydrators utilizing recirculation of exhaust air and heat recovery heat exchangers. Final report.** Groh, J.E. (Arizona Univ., Tucson (USA). Environmental Research Lab.). Dec 1977. Contract EY-76-S-02-2916. 26p. Dep. NTIS, PC A03/MF A01.

Dehydration of fruit in the United States is often done by means of a tunnel dehydrator utilizing large quantities of fossil fuel. Existing dehydrators have been designed to operate with maximum product through-put and with little regard for energy efficiency. Incorporating controlled recirculating air dampers and thermal energy recovery equipment on the exhaust air, calculations and preliminary tests show that the energy required in dehydration may be cut by up to 40%. During this work, one tunnel was modified and upgraded in a commercial 24-tunnel facility to demonstrate the potential savings. A primary element of this program, the heat recovery heat exchanger, operated below specifications. The manufacturer, Hughes Aircraft Company, has determined that the heat exchanger design was based on faulty data, and is constructing a second exchanger which can be installed and tested during a subsequent program.

37590 (TID—28401) **Slag waste heat recovery and utilization in the elemental phosphorus industry. Quarterly progress report, October 28, 1977—January 28, 1978.** Zanders, D.L. (Monsanto Research Corp., Dayton, Ohio (USA)). 27 Jan 1978. Contract EC-77-C-01-5088. 16p. Dep. NTIS, PC A02/MF A01.

Progress is reported on the technical evaluation of two concepts considered for recovering energy from molten slags. The two concepts are the prilling tower (cooling the dispersed slag in air) and the molten tin bath (cooling the slag through a molten tin support). In order to establish the current status and to evaluate the potential of energy recovery from slags, information on slag handling practices, slag composition, and slag rates for major slag producing industries is being developed through literature searches and industry contacts. A summary of progress on the four tasks designed to establish technical, environmental, economic, and commercial feasibilities of slag energy recovery is given, including the task schedules and task elements completed to date.

37591 Economizer utilizing exhaust gas. Furukawa, T.; Ozaka, K. (to Ishikawajima-Harima Jukogyo Kaisha). US Patent 4,079,702. 21 Mar 1978. Priority date 10 Sep 1975, Japan. 4p.

The present invention discloses an economizer for absorbing heat of combustion products. The surfaces of a series of continuous tubes extended through an exhaust gas pipe or duct are lined with glass pipes, the clearance between the exhaust pipe or duct wall and the tubes extended therethrough is sealed with gaskets, and water is circulated through the tubes.

37592 Heat transfer characteristics of the plate heat exchanger. Ando, A.; Oda, N.; Shibamoto, N. *Hitachi Zosen Giho;* **39**: No. 1, 1-7(1978). (In Japanese).

A counter flow type of plate heat exchanger has been newly developed for the recovery of flue gas energy. This heat exchanger consists of several unit blocks, and each block comprises a lot of thin steel waved plates welded to each other. This heat exchanger is provided with merits such as high efficiency, easy exchange of blocks, low price, and no gas-leak. To examine its heat transfer characteristics and to confirm the usefulness, experiments were carried out by employing a test heat exchanger with a block of actual size and using flue gases. The results were as follows: the waved plates used have excellent heat transfer characteristics, which will make the erection area of this type of heat exchanger smaller; the pattern of the performance reduction by soot accumulations can be explained by soot layer modeling; and soot accumulations can be released from the heat exchanger by steam blowing or by water injection.

INDUSTRIAL WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 37253, 37596, 38200

37593 Method and apparatus for removing volatile fluids. Helleur, D.E. US Patent 4,079,585. 21 Mar 1978. Priority date 9 Aug 1972, United Kingdom of Great Britain and Northern Ireland (UK). 20p.

A method and apparatus are described for the removal and recovery of volatile or evaporable substances from materials containing them. In other embodiments, the invention is readily applicable for the simultaneous incineration and concentration of such materials, particularly spent water-diluted effluents from industries and municipalities as well as for the generation of electric power from

various thermal fuels, particularly power gas produced from coal or oil. In further embodiments, the reclamation of oil, from oil sands and shales, is effected as well as the cyclic pulping of cellulosic materials with cyclic recovery of heat and chemicals.

37594 From waste polymers to durable board. Lock, J. *Processing;* **24**: No. 2, 49, 51(Feb 1978).

Practical processes now exist for the conversion of mixed waste plastics into products with well defined marketable characteristics. Until comparatively recently it was not thought feasible to mix such polymers as polyethylene, polystyrene, ABS and nylon in the same product, but now both shaped objects and sheet (board) can be produced. One enterprising company began production in 1977 of a very successful board using a process which can be further developed to make shaped objects. This process and the product results are discussed.

37595 Treatment of industrial effluents. Cahey, A.G. London; Hodder and Stoughton (1977). 378p.

The textbook is designed for students of water resources technology and as a guide for water quality engineers and those concerned with industrial effluents. The authors come from water authorities, industry and the academic world. Among the subjects considered are microbes and effluent treatments; legal aspects of pollution; analytical techniques; bio-oxidation; physical treatment; biological and ecological aspects of waste treatment; biological treatment of coke-oven liquors; water tracing.

MUNICIPALITIES AND COMMUNITY SYSTEMS

REFER ALSO TO CITATION(S) 37511

MUNICIPAL WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 37593, 38230, 38231, 38259

37596 Solid waste disposal system. Choi, C.K.; Morey, B.W.; Frischmuth, R.W.; Tassoney, J.P.; Gundzik, R.M. (to Occidental Petroleum Corp.). US Patent 4,077,847. 7 Mar 1978. Filed date 31 Aug 1976. 30p.

A system for segregating through comminution and classification solid waste into ferrous metal, inorganic, and organic fractions is described. The inorganic fraction is further classified into aluminum and glass fractions. The organic fraction is further comminuted, dried and fed to a pyrolysis system where it is converted to gas for use in drying the organic material for feed to the pyrolysis system, pyrolytic oils and char. The principal saleable products recovered are char, pyrolytic oils, glass, aluminum, and ferrous metal.

37597 Chemical composition of sewage sludges and analysis of their potential use as fertilizers. Sommers, L.E. (Purdue Univ., Lafayette, IN). *J. Environ. Qual.;* **6**: No. 2, 225-231(1977).

Electron Spectroscopy for Chemical Analysis (ESCA) was used to provide information concerning the chemical bonding of zinc and copper present in the sludge obtained from the Dayton, Ohio sewage treatment plant. The binding energy of the Zn 2P/sub 3/2/ electron in sludge when placed under a vacuum of 10^{-7} Torr was 1023.8 +- 0.2 eV and the binding energy of the Cu 2p/sub 3/2/ electron in the sludge under similar conditions was 937.2 +- 0.3 eV. These energies are characteristic of both Zn and Cu being in the positive two oxidation state. The electronegativity of the ligand attached to either of these metals was found to be 3.5 +- 0.1 on the Pauling scale. This indicates that Zn and Cu exist in similar compounds, that the ligand binding site is oxygen, and that the possible compounds include carbonate, carboxylate, phosphate, nitrate, silicate, and/or oxide. ESCA, when used in conjunction with other methods, offers excellent potential for more specifically identifying the chemical form of metal in sludge or sludge mixtures.

ADVANCED AUTOMOTIVE PROPULSION SYSTEMS

INTERNAL COMBUSTION ENGINES

REFER ALSO TO CITATION(S) 37613, 37614

37598 Fuel measuring system for engines. Erwin, C.L. Jr. US Patent 4,079,623. 21 Mar 1978. Filed date 12 Apr 1976. 16p.

A volumetric measuring device arranged for use with a fuel system for engines which return unburned fuel is described. The measuring device has a movable measuring member. An electric sensor in an electric circuit senses movement of the movable member. Indicating or recording devices, or both, are responsive to the electric sensor to indicate and record fuel flow through the measuring device. One system of the invention utilizes two measuring devices to provide a differential in output of the electric sensors for accurate measurement. Structure for treatment of the fuel may be employed with the system for cooling, removing bubbles, or the like. An alternative structure for sensing movements of the movable member comprises a magnetic pickup. Another concept of the invention conducts fuel from the measuring device, which may or may not be volumetric, to the engine in bypassing relation to the structure for treating the fuel. In further concepts of the invention, the movable member of the measuring device is operated by the simultaneous admission and discharge of fuel, and the measuring device is connected prior to the combining of the recirculated fuel and a fuel supply for the engine.

SPARK-IGNITION

REFER ALSO TO CITATION(S) 37608

37599 Forced air circulation heating unit. Whiteley, I.C. US Patent 4,077,388. 7 Mar 1978. Filed date 14 Apr 1975. 8p.

A forced air circulation heating unit is formed of a U-shaped conduit for placement on the floor of a fireplace and a blower unit including a fan mounted in an insulating housing for forcing air through the conduit to be heated in the fireplace and discharged into a room. The housing has an interior lining of heat and sound insulating material such that the blower unit can be positioned within the fireplace while protecting the fan from heat and reducing noise from the fan. Jets are provided on the conduit to direct streams of air along legs of the conduit toward a base or heating chamber joining the legs in order to force air toward the center of the base and underneath fuel resting on the floor of the fireplace thereby reducing carbon monoxide, facilitating the starting of fires and reducing smoking.

DIESEL

REFER ALSO TO CITATION(S) 37576, 37895

37600 MAN unveil their new diesel range. Jeffs, E. (ed.). *Energy Int.;* **14**: No. 8, 16-17(Aug 1977).

Two new 4-stroke models and three medium-speed engines already available, covering a power range from 1200 to 240,000 kW, are described. All five engines feature constant pressure turbocharging, which offers a superior heat recovery potential in the exhaust gases, as compared with pulse-pressure turbocharging and, above a certain threshold level of mean effective pressure, lower fuel consumption. Other advantages of constant pressure turbocharging are that only one manifold is required per cylinder bank regardless of the number of cylinders. Benefits are a long service life, reliability of the exhaust manifolds and ease of access to components requiring maintenance.

37601 Thermal-load criterion for the piston of a diesel engine. Gruenwald, B. (Polytechnic Inst. of Bucharest). *Rev. Roum. Sci. Tech., Ser. Electrotech. Energ.;* **22**: No. 4, 587-596(1977).

A new equation is presented for the heat flux which is transferred through the piston head. The equation evolved from theoretical assumptions and is much more complex and has a different weight of the reference criterion than equations already known from previous work. The dependence of the new criterion on the mean effective pressure is established. Finally, the dependence of the thermal load upon different factors has been found to be more complicated than that resulting from previous work.

37602 Experimental research concerning the influence of constructive factors on the mixture formation in compression ignition engines with wall injection. Vasilescu, C.A. (Polytechnic Inst. of Bucharest). *Rev. Roum. Sci. Tech., Ser. Electrotech. Energ.;* **22**: No. 4, 597-604(1977). (In French).

Experiments on a single cylinder engine and wall injection are presented. The geometry of the nozzle, the diameter of the combustion chamber and the intensity of the organized movement of the air in the cylinder (due to a shrouded valve) are investigated. There are no conclusive results concerning the influence of the geometrical modification of the nozzle, but an optimum ratio between the diameter of the combustion chamber (measured at the piston head surface) and the cylinder bore was found. It was shown that inducing a swirl into the cylinder 4 times greater than that induced by a standard intake pipe, was necessary.

37603 Piston slap as a noise source of automotive diesel engine. Usami, T.; Wada, S. (Mitsubishi Motors Corp., Japan). *Tech. Rev., Mitsubishi Heavy Ind.;* **13**: No. 3, 233-240(Oct 1976).

Vehicles have four major noise sources—engine, cooling fan, exhaust systems, and tires. It is generally found that on current trucks, engine-radiated noise, mainly induced by piston slap, is the most important source. Results of theoretical calculation undertaken to predict piston behavior are presented and compared with results of measurements of engine noise and cylinder liner vibration where piston slap control measures were taken. From the experiments it can be concluded that offsetting the piston pin is the easiest and most inexpensive method of controlling piston slap on current production engines.

EXTERNAL COMBUSTION ENGINES

STIRLING CYCLE

37604 Prospects of ceramics in Stirling engines. Holgersson, S.; Lia, T.; Gummesson, S. *Diesel Eng.;* **73**: No. 795, 213-219(Win 1977).

Low noise level, low content of hazardous exhausts and multi-fuel acceptance are some interesting qualities of the Stirling engine, making it an environmentally-compatible energy converter for special markets where such properties are important. However, with depleting energy sources another quality--its potential for high efficiency--is becoming most important. The Stirling engine's efficiency is highly dependent on high temperature materials like ceramics, also interesting from the point of view of reducing costs. A discussion is given of the outlook for ceramics in Stirling engines and what is being done in this area at United Stirling of Sweden, where Stirling engine development has been carried out since 1968.

ELECTRIC-POWERED SYSTEMS

REFER ALSO TO CITATION(S) 37606, 37607

37605 (DOE/CS—0026/1(Vol.2)(No.1)) **EHV/quarterly report.** (Department of Energy, Washington, D.C. (USA). Div. of Transportation Energy Conservation). Apr 1978. 19p. Dep. NTIS, PC A02/MF A01.

The quarterly report on the Electric and Hybrid Vehicle Program features a state-of-the-art assessment of the vehicles as a means of establishing a baseline for program development. Other articles cover development of product improved vehicles using off the shelf technology and RD and D to optimize integrated designs for vehicle systems. "A view from the Senate" is from an address by Senator James A. McClure, presented at the first EHV Contractors' Coordination Conference. In the article, Vehicle System Development, some data on the Garrett and G.E. electric-powered vehicles are included. (MCW)

HYBRID SYSTEMS

REFER ALSO TO CITATION(S) 37605

VEHICLE DESIGN FACTORS

ENGINE-TRANSMISSION MATCHING

37606 (COO—2835-2) **Characterization study of an electric motor-transmission system for electric vehicles.** Marcus, A.; Pinkus, O. (Mechanical Technology, Inc., Latham, N.Y. (USA)). Sep 1977. Contract EY-76-C-02-2835. 112p. (MTI—78TR2). Dep. NTIS, PC A06/MF A01.

A unique electric transmission concept, consisting of two traction motors in tandem, for use in automotive vehicles is described. The device does away with the requirement of intermittent current supply at low speeds, and is shown to be superior to conventional electric motor drives with regard to efficiency, flexibility of torque-speed requirements, control, and adaptability to regenerative braking. The electric motor-transmission can operate in either the differential, single-motor, or additive mode, producing both forward and reverse speeds while covering the entire spectrum of torque, speed, and power required by an automotive vehicle. A detailed study of a 7.5 kW model was performed, providing performance data, current drain, output, efficiencies, and other relevant system characteristics. Based on this data, a preliminary design is formulated including estimates of size, weight, and cost. A catalog of specifications for power ratings ranging from 3.7 kW to 15 kW is included, so that the automotive designer may select a unit most appropriate to his vehicle. Recommendations are made for advancing the technology of high-speed dc machinery and a development program for the construction and testing of an appropriate motor-transmission prototype for demonstration purposes.

37607 (COO—2835-3) **Advanced electric motor-transmission for electric vehicles. Development plan. Technical report.** Marcus, A. (Mechanical Technology, Inc., Latham, N.Y. (USA)). Nov 1977. Contract EY-76-C-02-2835. 59p. (MTI—78TR4). Dep. NTIS, PC A04/MF A01.

A plan of action is presented to design, fabricate, and test on all-electric motor-transmission system for an electric-powered vehicle. Topics discussed include: (1) a program plan for development of an electric motor-transmission; (2) statement of work and general approach; (3) technical discussion; and (4) program organization. The program proposes to demonstrate, by means of a full sized laboratory model, the capability of a unique and highly efficient all-electric variable ratio electric motor-transmission. This development plan presents the demonstration portion of an earlier program which had reduced the concept to practice and characterized the system operation, performance, and capability for an advanced electric vehicle propulsion system.

ENGINE SYSTEM

REFER ALSO TO CITATION(S) 37616, 37617, 37618

37608 Internal combustion engine. Yoshimura, T.; Sanezawa, F. (to Nissan Motor Co., Ltd.). US Patent 4,079,588. 21 Mar 1978. Priority date 5 Jun 1975, Japan. 4p.

An internal combustion engine is disclosed in which each pair of cylinders has a Siamese exhaust port. Each of the exhaust ports is designed so that the ratio of a surface area (F) exposed to the exhaust gas discharged from one of the cylinders to the minimum cross-sectional area (S) through which the exhaust gas flows (F/S) ranges from 3 to 6.

37609 Two-stroke-cycle dual-piston internal combustion engine. Buechner, B. US Patent 4,079,705. 21 Mar 1978. Priority date 28 Mar 1975, German, Federal Republic of (F.R. Germany). 10p.

In a two-stroke-cycle dual-piston engine in which a fuel mixture is compressed in the crank chamber by the reciprocating pistons, the compressed fluid flows from the crank chamber and a compartment of one cylinder open toward the crank chamber through a transfer port into a compartment of the other cylinder between the piston and the cylinder head. The fuel then flows through a combustion chamber in the cylinder head into the communicating compartment of the first-mentioned cylinder, and the exhaust gases are ultimately discharged through an exhaust port. The transfer port and exhaust port are opened and closed by control devices on the pistons and are both controlled by the piston in the first-mentioned cylinder in such a manner that the exhaust port is opened before the transfer port and closed after the transfer port.

37610 Fuel injection system of internal combustion engine. Shirose, H. (to Nissan Motor Co., Ltd.). US Patent 4,079,717. 21 Mar 1978. Priority date 23 Jun 1975, Japan. 8p.

A device functions to vent only gases trapped in a pressure line connecting fuel pump and fuel injectors to rapidly deliver liquid fuel from the fuel pump through the pressure line to the fuel injectors.

37611 Fuel injection system. Holzbaur, S. (to Robert Bosch GmbH). US Patent 4,079,718. 21 Mar 1978. Priority date 29 Mar 1974, German, Federal Republic of (F.R. Germany). 10p.

A fuel injection system for externally ignited internal combustion engines includes a device for injecting fuel into an air stream and an air measuring device comprising a valve having an airfoil portion. The air measuring valve is pivotably mounted within the suction tube to the air stream flowing through the suction tube. The air measuring valve is exposed to a combination of forces. One of the forces is an impedance induced force developed in accordance with the principle associated with impedance type valves and as a function of the pressure prevailing in front of and behind the air measuring valve when viewed in the direction of flow of the air stream in the suction tube. The other force is a lift force and is developed in accordance with the airfoil principle and as a result of an air flow about the airfoil portion of the air measuring valve. The impedance induced force occurs when the air flow through the suction tube is small, whereas when the air flow through the suction tube is large, the predominant force is the lift force developed in accordance with the airfoil principle.

37612 Internal combustion engine valve stroke adjusting device and combination thereof with engine. Buehner, J.F. US Patent 4,077,369. 7 Mar 1978. Filed date 21 Apr 1976. 10p.

A power driven remote control device is operable from a location remote from the engine for adjusting the length of stroke of one or more valves of an internal combustion engine during engine operation and while maintaining the valving cycle substantially unchanged. The strokes of all of the valves of the engine can be adjusted equal or preselected amounts concurrently. The control is arranged so that it can be installed on a conventional engine to

provide an operating combination therewith without substantial modification of the existing engine structure. In this combination, the control utilizes fluid pressure generated by the engine, such as the oil pressure from the engine oil pump, for changing the length of valve strokes while isolating the valves from any rocking that might otherwise be imposed by the valve driving cam or tappet.

37613 Internal combustion engine fuel economy improvement system. Spangenberg, H.E. US Patent 4,077,370. 7 Mar 1978. Filed date 19 Aug 1975. 20p.

Apparatus and methods are disclosed for assisting the driver of an automobile driven by a drive system including an internal combustion engine to improve fuel economy. The internal combustion engine drive system has an air intake manifold, a throttle valve, an accelerator pedal and a linkage coupling the accelerator pedal to the throttle valve. The effective length of the linkage between the accelerator pedal and the throttle valve is biased to an extreme value at which the throttle valve is in a closed position when the engine is deactivated. The existence and intensity of a vacuum in the air intake manifold is determined. The effective length of the mentioned linkage is maintained biased at the extreme value at vacuum intensities up to a vacuum intensity existing in the air intake manifold at an ideling rate of rotation of the internal combustion engine. On the other hand, the effective length of the mentioned linkage is varied so as to actuate the throttle valve toward a closing position in response to vacuum intensities above the vacuum intensity existing at the idling rate of rotation.

37614 Fuel saving system for automobiles. Drori, M. US Patent 4,077,371. 7 Mar 1978. Priority date 27 Mar 1975, Israel. 4p.

A fuel control system for automobile engines comprises load-sensor means for sensing the load on the engine, and fuel-mixture-ratio control means responsive to the load-sensor means to control the fuel-mixture ratio such as to produce a richer fuel mixture with increased loads, and a leaner fuel mixture with decreased loads.

37615 Spark plug pressure transducers for measuring indicated work. Evers, L.W. Warrendale, PA; Society of Automotive Engineers, Inc. (1978). 12p. (CONF-780208—2). .

From Society of Automotive Engineers International Automotive Engineering Congress and Exposition; Detroit, MI, USA (Feb 1978).

Spark plug pressure transducers were used in an experimental study to determine the suitability of such devices for measuring indicated work in internal combustion engines. Three piezoelectric transducers were studied to compare response of the spark plug unit with a reference device; the comparative data were obtained from a single-cylinder engine fitted with both a flush mounted pressure transducer and a spark plug pressure transducer. Signals from both transducers were recorded simultaneously, combined with a volume function, and analyzed for output differences. The volume function used in the calculations of indicated work was generated about an angular reference point recorded with the pressure data. Typically, indicated work calculated from the spark plug pressure transducer was found to be from -3.2 to +7.6 percent of that calculated from the flush mounted pressure transducer. The sources of inaccuracy associated with the spark plug pressure transducer are discussed.

EMISSION CONTROL

REFER ALSO TO CITATION(S) 37608, 37895

37616 Refinements to constant depression carburetors. Laprade, B.R.; Laprade, X.J.; Gele, P.J. US Patent 4,079,713. 21 Mar 1978. Priority date 18 Jun 1975, France. 4p.

In a carburetor, the dosing needle for regulating the fuel flow is connected to a second movable element, such as a membrane or piston. The second movable element is movable relative to a first movable element, one side of the second movable element being subject to atmospheric pressure and the other side of the second movable element being subject to the partial vacuum prevailing upstream of the throttle valve. The system is modulated by an electromagnetic valve capable of supplying atmospheric pressure, the electromagnetic valve being controlled by a probe arranged in the exhaust pipe which supplies a signal representative of the composition of the exhaust gases.

37617 Air—fuel mixture supply device of internal combustion engine. Saito, M. (to Nissan Motor Co., Ltd.). US Patent 4,079,714. 21 Mar 1978. Priority date 31 Mar 1975, Japan. 8p.

The fuel passing through the main discharge nozzle of a carburetor is positively vibrated or is caused to pulsate to supply well atomized fuel into the air-fuel mixture induction passage of the carburetor in order to improve the combustion condition within the combustion chambers of an internal combustion engine.

37618 Gasoline engine fuel interrupter. Firey, J.C. US Patent 4,077,381. 7 Mar 1978. Filed date 28 Jul 1976. 12p.

The invention described provides means for stopping the flow of gasoline through a gasoline engine during the initiation of starting. In this way the engine contribution of smog forming materials is reduced and the engine is more easily started. This improved starting of the engine is achieved by increasing the portion of the work of compression available to usefully evaporate gasoline. To accomplish these results a stop valve is interposed between the fuel metering system and the fuel delivery jet of the engine carburetor, the valve being so automatically actuated so as to open only after a delay time interval of engine cranking during cold starting. The valve may also be closed automatically whenever the engine ignition is turned off thus assuring a prompt stopping of the engine.

HYDROCARBONS

REFER ALSO TO CITATION(S) 37609, 37619

ALTERNATIVE FUELS

REFER ALSO TO CITATION(S) 37036, 37037, 37038

37619 Internal combustion engine operated on injected fuel supplemented with hydrogen. Yamane, K.; Morita, A.; Ueno, Z. (to Nissan Motor Co., Ltd.). US Patent 4,079,703. 21 Mar 1978. Filed date 17 Dec 1975. 6p.

A lean mixture, rich in hydrogen, is introduced into the combustion chamber. Fuel is then injected to the center of the chamber to provide a rich strata. The rapid flame front propagation due to the hydrogen minimizes the HC production quench.

MATERIALS

METALS AND ALLOYS

REFER ALSO TO CITATION(S) 36873

37620 Advanced high temperature materials: technological and industrial aspects. Kroeckel, H. (ed.). Paris; Masson (1977). 178p. (CONF-760162—).

From 1. colloquium on advanced high temperature materials; Petten, Netherlands (29 Jan 1976).

The primary purpose of the conference was to review, discuss and compare the practical requirements and R and D needs for the area of "advanced high temperature materials: technological and industrial aspects." (GHT)

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 37662, 37795

37621 (SAND—78-8203) **Braze metal wettability on JBK-75.** Boehmke, J.C. (Sandia Labs., Livermore, Calif. (USA)). Feb 1978. Contract EY-76-C-04-0789. 20p. Dep. NTIS, PC A02/MF A01.

Brazing offers an alternative method of joining the alloy JBK-75. This report discusses a braze study conducted to determine techniques and braze alloys suitable for joining JBK-75.

37622 (Y—2112) **Video monitoring system for enriched uranium casting furnaces.** Turner, P.C. (Oak Ridge Y-12 Plant, Tenn. (USA)). Mar 1978. Contract W-7405-ENG-26. 16p. Dep. NTIS, PC A02/MF A01.

A closed-circuit television (CCTV) system was developed to upgrade the remote-viewing capability on two oralloy (highly enriched uranium) casting furnaces in the Y-12 Plant. A silicon vidicon CCTV camera with a remotely controlled lens and infrared filtering was provided to yield a good-quality video presentation of the furnace crucible as the oralloy material is heated from 25 to 1300°C. Existing tube-type CCTV monochrome monitors were replaced with solid-state monitors to increase the system reliability.

37623 Apparatus for extruding wires of soft metals under vacuum or inert atmospheres. Kayser, F.X.; Rashid, M.S. (Ames Laboratory-USDOE and Department of Materials Science and Engineering, Iowa State University, Ames, Iowa 50011). *Rev. Sci. Instrum.;* 49: No. 5, 639-642(May 1978).

A bakeable apparatus is described that was constructed for extruding wires from small ingots of soft metals like the alkalis, the alkaline earths, and the divalent rare earths, while at the same time safeguarding the purity of the sample material. The unit is complete-

ly enclosed yet small enough to be hand transferred into and out of an inert atmosphere glove box where load/unload operations are performed. Extrusions are effected with the apparatus outside the glove box but with the sample material under the captured atmosphere of the box or under a vacuum. Given an external heating source it is possible to carry out extrusions at temperatures above room temperature as well as in situ recrystallizations of extruded materials.

37624 Surface effects affecting ac losses of Nb_3Sn. Bussiere, J.F.; Kovachev, V.T. (Brookhaven National Laboratory, Upton, New York 11973). *J. Appl. Phys.;* **49**: No. 4, 2526-2530(Apr 1978).

60-Hz losses of Nb_3Sn were found to be considerably reduced by anodizing. Anodizing followed by etching in dilute HF was also studied and found to be less effective because of increased surface roughness and hydrogen inclusion after prolonged contact with the acid. The increase of ac losses from contact with the bronze at the surface of Nb_3Sn made by solid-state diffusion was investigated. Both a surface effect (proximity) and thermal stress were found to contribute to the increased losses.

37625 Radioactive shielding material. Reiss, M.M. (to Atomic Products Corp.). US Patent 4,081,689. 28 Mar 1978. Filed date 17 Sep 1976. 4p.

A radioactive shielding material is formed by coating or plating depleted uranium ^{238}U with a layer of beta ray impermeable material. The material has particular application for use as a hypodermic syringe shield component, and as shields for other hand-held instruments carrying or impregnated with radioactive materials.

37626 Ultrafast quenching of the compound V_3Sn. Savitskii, E.M.; Efimov, Y.V.; Frolova, T.M. (A. A. Baikov Institute of Metallurgy, Academy of Sciences of the USSR, Moscow). *Sov. Phys. - Dokl. (Engl. Transl.);* **22**: No. 9, 523-525(Sep 1977).

The superconducting transition temperature of V$_3$S/sub n/-based alloys was measured as a function of composition after the samples were fast-quenched and annealed.

37627 Structure of heteroepitaxial tungsten deposits with the (110) orientation obtained by the electrolysis of molten salts. Baraboshkin, A.N.; Plaksin, S.V.; Ksenofontova, T.B.; Zavorokhin, L.N. (Institute of Electrochemistry, Ural Scientific Center, Academy of Sciences of the USSR). *Sov. Phys. - Crystallogr. (Engl. Transl.);* **22**: No. 4, 511-512(Jul 1977).

Epitaxial deposition of tungsten films with (110) orientation on various single crystal substrate faces has been accomplished by electrolysis of a molten mixture of sodium tungstate and tungsten trioxide at 850°C.(AIP)

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 37660, 37677, 37680

37628 Ordered oxygen overlayer associated with chemisorption state on Al(111). Flodstroem, S.A.; Martinsson, C.W.B.; Bachrach, R.Z.; Hagstroem, S.B.M.; Bauer, R.S. (Department of Physics and Measurement Technology, Linkoeping University, S-581 83 Linkoeping, Sweden). *Phys. Rev. Lett.;* **40**: No. 13, 907-910(27 Mar 1978).

We present experimental evidence of a unique, ordered chemisorption phase in the initial interaction of oxygen with the Al(111) surface. At high oxygen exposure or high temperature, this phase is shown to transform irreversibly to a bulklike aluminium oxide. The measured temperature dependence, as well as the low-energy electron diffraction, suggests threefold, centered bonding site. A comparison between calculated and experimental valence-band density of states for the oxygen-covered Al(111) surface is made for the estimated oxygen-atom-substrate-surface distance.

37629 Precipitate phases in Type 321 stainless steel after aging 17 years at approximately 600°C. Leitnaker, J.M.; Bentley, J. (Oak Ridge National Lab., TN). *Metall. Trans., A;* **8**: No. 10, 1605-1613(Oct 1977).

Long term aging of type 321 stainless steel indicates TiC, not $M_{23}C_6$, is the thermodynamically stable carbide phase. A theory is developed to explain appearance of $M_{23}C_6$ at intermediate times. The theory also indicates a means for preventing $M_{23}C_6$ formation and hence sensitization of the steel to intergranular corrosion. The amount of sigma found correlates well with results from shorter time studies. Two minor, still unidentified phases were seen along with $Ti_4C_2S_2$. 8 figures, 4 tables.

37630 Migration of tilt boundaries and facet development in thin gold bicrystals. Allen, R.M. (Cornell Univ., Ithaca, NY); Goodhew, P.J. *Acta Metall.;* **25**: No. 9, 1095-1107(Sep 1977).

Thin films of gold were welded together to create bicrystals containing [001] twist grain boundaries. The bicrystals were heated in the transmission electron microscope and the migration of first twist and subsequently tilt regions of the boundary was observed directly. The tilt boundaries showed a tendency to facet which grew less pronounced as the twist angle was increased. The preferred boundary planes appeared to be controlled either by inhomogeneities in the thickness of the original single crystal films or by the lowest energy section of the 0-lattice, which in this case is the plane with the highest density of 0-points. The interaction of a migrating boundary with bubbles of a range of sizes was also observed and the pinning effects are reported. 7 figs., 32 refs.

37631 Crystal structure of the compound $U_2Co_3Si_5$. Aksel'rud, L.G.; Yarmolyuk, Y.P.; Gladyshevskii, E.I. (State University, L'vov). *Sov. Phys. - Crystallogr. (Engl. Transl.);* **22**: No. 4, 492-493(Jul 1977).

X-ray analysis of a single crystal indicated that $U_2Co_3Si_5$ is orthorhombic with space group Ibam. Interatomic distances and coordination numbers have been determined and the relationship to the $LiCo_2Si_2$ tetragonal structure is discussed.(AIP)

37632 On the upper limit to equilibrium segregation at a grain boundary. White, C.L. (Oak Ridge National Lab., TN); Stein, D.F. *Scr. Metall.;* **11**: No. 7, 613-616(Jul 1977).

It is shown that the upper limit for equilibrium solute segregation at a grain boundary, as formulated by Cahn and Hilliard (Acta Met. 7:219-221(1959)), is valid not only for Henrian behavior of the bulk solvent-solute system, but for other behavior. This behavior is shown to be satisfied for negative deviations from Henry's Law. This suggests that, while the criticisms of Bitler are valid for some classes of bulk thermodynamic behavior, the equation does represent a valid upper bound in many other cases where detailed solution activity data may not be available.

37633 Magnetic relaxation phenomena of hydrogen in α-iron. Vetter, K.; Steeb, H.; Kronmueller, H. (Max-Planck-Institut fuer Metallforschung, Stuttgart). pp 8p, Paper 2C5 of Hydrogen in metals. Volume 6. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P6.

Measurements of the magnetic relaxation in hydrogen-charged α—Fe crystals were performed in the temperature range from 4°H to 270°K. The hydrogen cold-work peak at 130°K was shown to be composed of two subpeaks, which could be attributed to the relaxation of edge and screw dislocations decorated by hydrogen. 8 figures.

37634 Magnetic orientation after-effect of TiH-complexes in α-iron. Vetter, K.; Kronmueller, H. (Max-Planck-Institut fuer Metallforschung, Stuttgart). pp 7p, Paper 2C6 of Hydrogen in metals. Volume 6. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P6.

In ferromagnetic Fe—Ti alloys (2% Ti, 10% Ti) the Snoek-type magnetic relaxation of TiH and TiD complexes was studied. Each hydrogen isotope generates two relaxation peaks which could be attributed to different relaxation modes of the diatomic complex. The activation energies showed a considerable isotope effect. 6 figures, 1 table.

37635 Strain field around deuterium in niobium. Bauer, G.S. (Inst. F. Festkoerperforschung, KFA, Juelich, Ger.); Schmatz, W.; Just, W. pp 8p, Paper 2C15 of Hydrogen in metals. Volume 6. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P6.

From a measurement of the quasielastic diffuse neutron scattering from a Nb crystal loaded with 2.56% deuterium, it could be shown that the center of the strain field is the tetrahedral interstitial site and that its symmetry is cubic. 4 figures.

37636 Edgewise growth of Widmanstaetten alpha precipitates in brass. Simonen, E.P. (Battelle Northwest, Richland, WA); Trivedi, R. *Acta Metall.;* **25**: No. 8, 945-950(1977).

The lengthening rates of needle and plate precipitates of alpha phase from beta brass are examined. Measured kinetics are compared with rates expected from volume diffusion considerations. Needle lengthening in ordered beta brass is found to be compatible with the volume diffusion model when the interfacial structure is considered to be incoherent. However, at temperatures above the order—disorder transition, the kinetics are consistent with the volume-diffusion model only if the precipitate has a zinc concentration slightly in excess of its equilibrium value. Furthermore, the analysis of the growith kinetics of plate precipitates agrees with experimental results for a semicoherent interfacial structure at the tip of the plate when a small deviation from equilibrium composition is considered in the precipitate. The departure from equilibrium in the plate

precipitates is predicted to increase wth decreasing transformation temperature. The above conclusions are shown to be compatible with precipitate composition measurements reported in literature, and with the known interfacial structures of plate and needle precipitates in various other alloy systems. 7 figures.

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 36643, 37279, 37309, 37701, 37819

37637 (AERE-R—8605) **Creep in a Type 316 stainless steel.** Morris, D.G. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). Nov 1976. 27p. Dep. NTIS (US Sales Only), PC A03/MF A01.

Dislocation creep rates at 625°C have been examined in Type 316 stainless steel in both the solution treated condition and after prestraining to the secondary creep stage at several initial stresses. The application of particle-induced internal stress ideas does not provide a completely satisfactory interpretation of the creep behavior and a more realistic approach, based on a detailed examination of the dislocation link strength distributions and the calculation of the mobile dislocation fraction, has been used.

37638 (AERE-R—8725) **Cyclic creep behaviour of Type 316 stainless steel.** Morris, D.G.; Harries, D.R. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). Mar 1977. 30p. Dep. NTIS, PC A03/MF A01.

The cyclic creep behavior of a Type 316 stainless steel at 625°C was examined as a function of the maximum applied stress and frequency by use of trapezoidal loading cycling between zero and a maximum stress. The so-called "static to dynamic creep transition" observed is interpreted in terms of recoverable anelastic strain behavior without using an internal stress argument. Over the range of experimental conditions examined, failure occurs by static creep modes, namely wedge crack nucleation and growth. The loading strain increments appear to be damaging to about the same extent as the much slower strain occurring at constant load such that it is the overall strain rate that determines the rate of damage. A cursory examination of squre-wave load cycling shows that the behavior is very similar to that observed during trapezoidal loading, and suggests that the rate of loading and unloading does not play an important part in determining the creep and rupture behavior. 11 figures, 3 tables.

37639 (GA-A—14747) **Design codes and lifetime prediction aspects for Alloy 800 for nuclear and non-nuclear applications.** Roberts, D.I. (General Atomic Co., San Diego, Calif. (USA)). Jan 1978. Contract EY-76-C-03-0167-050;EY-76-C-03-0167-056. 22p. (CONF-780310—2). Dep. NTIS, PC A02/MF A01.

From International conference on alloy 800; Petten, Netherlands (14 Mar 1978).

The evolution of the various grades of Alloy 800 is described in relation to both nuclear and non-nuclear applications, and comments are made on relevant service experience. The significance of the behavior characteristics of this alloy in relation to design and analysis methods is reviewed with particular emphasis on elevated temperature nuclear construction, where cyclic (creep-fatigue) as well as monotonic loads must be considered. The influence of fabrication factors, such as cold work and welding, and service factors, such as environment, on the properties of this material is also noted, and some comments on the potential applicability of probabilistic design methods are included.

37640 (GA-A—14778) **Gas-Turbine and Advanced-HTGR Materials Screening Test Program. Semiannual progress report for the period March 31, 1977—September 30, 1977.** Rosenwasser, S.N.; Johnson, W.R. (General Atomic Co., San Diego, Calif. (USA)). Jan 1978. Contract EY-76-C-03-0167-046. 47p. Dep. NTIS, PC A03/MF A01.

During the reporting period controlled impurity helium and air creep-corrosion tests on the original (Group I) 17 alloys in the program reached a maximum 14,000 hr duration, and similar tests on 9 additional (Group II) alloys reached a maximum of 5000 hr. The parallel unstressed controlled impurity helium and air fracture behavior tests on the same alloys reached a maximum of 10,000 hr. The initial tests in the parametric helium impurity corrosion study, which are investigating the effect of methane variation, were initiated and exceeded 1000 hr duration. The results of detailed metallurgical analyses and post-exposure tensile testing on the Group II alloys after 3000 hr stressed and unstressed exposure in controlled impurity helium at 800 to 1000°C are reported. Data for the wrought austenitic alloys Hastelloy X (new heat), Hastelloy S, RA 333, and HD 556 and the cast austenitic alloys HK 40, Supertherm, Manaurite 36X, Manaurite 36XS, and Manaurite 900 are reported. All alloys carburized significantly at 900 and 1000°C, with minor increases of carbon content exhibited at 800°C. The alloys were grouped with respect to the morphology of their oxide/carbide corrosion scales and the composition of these scales as identified by SEM microprobe analyses. Generally, carburization depths at 1000°C were greater in the wrought alloys than in the cast alloys. Room-temperature tensile properties of the wrought alloys were more severely affected by impure helium exposure than were the tensile properties of the helium-exposed cast alloys. Decreases in ductility of the exposed wrought alloys, presumably caused by carburization, were greater than would be expected from thermal aging alone.

37641 (IS-T—809) **Thermal and electrical conductivities of high purity tantalum.** Archer, S.L. (Ames Lab., Iowa (USA)). Jan 1978. Contract W-7405-ENG-82. 64p. Dep. NTIS, PC A04/MF A01.

Thesis.

The electrical resistivity and thermal conductivity of three high purity tantalum samples have been measured as functions of temperature over a temperature range of 5K to 65K. Sample purities ranged up to a resistivity ratio of 1714. The highest purity sample had a residual resistivity of .76 x 10^{-10}OMEGA-m. The intrinsic resistivity varied as $T^{3.9}$ from 10K to 31K. The thermal conductivity of the purest sample had a maximum of 840 W/mK at 9.8K. The intrinsic thermal resistivity varied as $T^{2.4}$ from 10K to 35K. At low temperatures electrons were scattered primarily by impurities and by phonons with both interband and intraband transitions observed. The electrical and thermal resistivity is departed from Matthiessen's rule at low temperatures.

37642 (IWGFR—11, pp 37-43) **Derivation of time dependent design-values for SNR 300 structural material.** Lorenz, H.; Breitling, H.; de Heesen, E. Oct 1976.

From IAEA international working group on fast reactors; Champion, PA, USA (27 Apr 1976).

In Specialists meeting on high temperature structural design technology of LMFBRs.

Time-dependent design values were derived from long-term creep rupture data for steel X 6 CrNi 1811 in the unwelded and welded condition. The design values had to satisfy the ASME CC 1592 criterea with respect to creep rupture strength, time to reach 1% strain and transition to tertiary creep as well as the requirement of German regulatory rules to properly account for weld bahaviour. For the evaluation and extrapolation 2 proven computer programmes were used. The design data derived under consideration of weld joints show relative good agreement with the values of ASME CC 1592. Consideration of welds leads to lower design values above 550°C and $5x10^3$ h with the difference between rolled and weld material becoming larger with increasing time and temperature.

37643 (KFK—2435, pp 250-260) **Investigations of the mechanical behavior of Zry-4 cladding material at high temperatures.** Bocek, M.; Petersen, C.; Schneider, H.; Schweiger, W. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Material- und Festkoerperforschung). Apr 1977. (In German).

In Second semiannual report 1976.

Analysis of the influence of ZrO_2 layers upon the strain rate sensitivity index m is made. The influence of the environment on the change in shape of Zry-4 specimens during a tensile test was examined. The influence of temperature excursions into the β-phase region on the plastic behavior of Zry-4 tensile specimens tested in the α-phase region was examined.

37644 **Environment enhanced crack growth effects in structural steels for water cooled nuclear reactors.** Suzuki, M.; Takahashi, H.; Shoji, T. (Tohoku Univ., Sendai (Japan)); Kondo, T.; Nakajima, H. (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan)). pp 161-169 of Influence of environment on fatigue. London; Mechanical Engineering Publications for I Mech E (1977).

From Meeting on the influence of environment on fatigue; London, UK (May 1977).

See CONF-770503—.

The effect of high temperature water environment on the fatigue crack growth characteristics of SA 533 Gr.B Class 1 steel was studied with major emphasis placed on the crack growth along the weld heat affected zone. Effects of stress wave form, hold-time on the base material were also examined in connection with the possibility of time-dependent cracking under sustained tensile stresses. Particular note was taken of the sensitivity of material to the environment-enhanced cracking with respect to its strong dependence on the microstructure and fabrication history.

37645 (LBL—7375) **Deformation of superplastic alloys at relatively low strain rates.** Grivas, D. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Feb 1978. Contract W-7405-ENG-48. 96p. Dep. NTIS, PC A05/MF A01.

Thesis.

The superplastic and sub-superplastic creep properties of Pb-Sn eutectic and Al-Zn eutectoid alloys were studied. Various thermomechanical treatments we tested to check the possibilities of whether the subsuperplastic deformation mechanism is affected by these treatments. All thermomechanical histories were found to

reveal the same stress exponent, which is believed to be indicative of the predominant mechanism. The mechanical data in the low stress region lead us to suggest that dislocation glide is the predominant mechanism in this region. At higher stresses extensive grain boundary sliding takes place and the dislocation movement is directed to relieve the stress concentration developed by the grain movement.

37646 (ORNL—5325) **Tensile properties of type 304 stainless steel.** Sikka, V.K.; Swindeman, R.W.; Booker, M.K.; Booker, B.L.P.; Stephenson, R.L. (Oak Ridge National Lab., Tenn. (USA)). Feb 1978. Contract W-7405-ENG-26. 129p. .

Tensile data obtained at Oak Ridge National Laboratory (ORNL) on 20 heats of type 304 stainless steel, both as received (mill annealed) and reannealed (laboratory annealed), are fitted to third-degree polynomials (P/sub p/) in temperature, and standard errors of estimate (SEE) are taken. Expected-minimum (lower-bound) curves for the data, taken to be P/sub p/—1.65SEE and P/sub p/—2SEE, are also found. This same analysis is performed on data from sources other than ORNL in the United States, from Japan, and from Great Britain and on combined sets of data from ORNL and these sources. Results are compared. For a reference heat, effects of strain rates on the tensile properties for ranges of strain rates 6.67 x 10^{-6} to 6.67 x 10^{-2} sec^{-1} and variations of the tensile properties with respect to different product forms and different specimen orientations were examined. Major findings are presented.

37647 (ORNL—5378) **Mechanical properties of tubesheet forgings for LMFBR steam generators.** Klueh, R.L.; Griffith, J.L. (Oak Ridge National Lab., Tenn. (USA)). Apr 1978. Contract W-7405-ENG-26. 36p. .

Tensile and creep-rupture properties were determined on a 2 1/4 Cr-1 Mo steel forging that had been manufactured by techniques typical of those used for tubesheets for steam generators. Specimens were taken from a 0.64-m-dia by 0.30-m-thick cylindrical forging in the as-received condition and on small pieces of the forging given a laboratory isothermal anneal. The microstructures in both conditions were primarily proeutectoid ferrite with small precipitate particles throughout. The laboratory isothermally annealed steel contained about 10 percent bainite and minor amounts of pearlite. On the other hand, the microstructure of the as-received forging depended on the position of the forging from which the specimen was taken. Near the external cylindrical surface, the microstructure contained about 10 percent bainite. For specimens taken at intervals toward the center of the forging, the amount of bainite increased and went through a maximum of about 30 percent, then decreased to about 25 percent at the center. The strength also went through a maximum with distance into the forging. This nonuniformity of microstructure and strength was attributed to a nonuniformity of cooling rate for the large forging. Detailed tensile and creep-rupture properties were determined for the as-received forging on specimens taken from about midway between the external cylindrical surface and the center, and these properties were compared with those for the laboratory isothermally annealed specimens. The tensile properties of the as-received steel exceeded those for the pieces of steel given the laboratory isothermal anneal, with the as-received steel showing a much greater dynamic strain aging effect. At high stresses, the creep-rupture properties of the as-received forging were greater than those of the steel that received the laboratory anneal.

37648 (SAND—77-2101) **Elastic—plastic response of 304 stainless steel beams to impulse loads.** Forrestal, M.J.; Sagartz, M.J. (Sandia Labs., Albuquerque, N.Mex. (USA)). Jan 1978. Contract EY-76-C-04-0789. 22p. Dep. NTIS, PC A02/MF A01.

The elastic-plastic response of 304 stainless steel beams is examined experimentally and analytically. Simply supported beams are loaded with half-sine distributed, short-duration magnetic pressure pulses and the response is monitored with a streak camera and strain gages. A approximate theory for peak deflection which includes strain rate effects and hardening is developed.

37649 (UCRL—13825) **Fatigue crack initiation and propagation in steels exposed to inert and corrosive environments. Final report, May 1, 1977—December 31, 1977.** Youseffi, K.; Finnie, I. (California Univ., Berkeley (USA); California Univ., Livermore (USA). Lawrence Livermore Lab.). Feb 1978. Contract W-7405-ENG-48. 196p. Dep. NTIS, PC A09/MF A01.

Portions of document are illegible.

The fatigue crack initiation life of AISI 1018 steel was investigated using compact tension specimens having sharp notch root radii. The data were analyzed using two methods for predicting initiation in strain cycling experiments. Also, another approach in which initiation is related to the stress intensity factor was developed. The next phase, that of propagation, was studied using AISI 1018 steel and a new high strength steel HY-180. The crack propagation data obtained for both steels tested in air can be described accurately by the power law first suggested by Paris, da/dN = C(ΔK)/sup n/, where a is the crack length, N the number of cycles, and C and n are material constants. However, the exponent n was found to be two times larger for AISI 1018 steel than HY-180 steel.

37650 (UCRL—80478) **Fundamental study of crack initiation and propagation.** Norris, D.M. Jr.; Reaugh, J.E.; Moran, B.; Quinones, D.F.; Wilkins, M.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 21 Dec 1977. Contract W-7405-ENG-48. 29p. (CONF-780207—1). Dep. NTIS, PC A03/MF A01.

From Electric Power Research Institute, plastic fracture public information meeting; Palo Alto, CA, USA (14 Feb 1978).

Objective is to determine the fracture toughness of A533B-1 steel by computer modeling Charpy V-notch tests. A computer model of ductile fracture was developed that predicts fracture initiation. The model contains a set of material-dependent parameters obtained by computer simulations of small specimen tests. The computer calculations give detailed stress and strain histories up to the time of fracture, which are used to determine the model parameter values. The calibrated fracture model, that correctly predicts fracture initiation (and initiation energy) in the Charpy specimen, may then be used to simulate tests of accepted fracture-toughness specimens and hence obtain fracture toughness. The model parameters were calibrated to predict fracture in four different test specimens: two different notched-tension specimens, a simple tension specimen, and a precracked compact-tension specimen. The model was then used in a computer simulation of the Charpy V-notch specimen to initiate and advance a flat fracture. Results were compared with interrupted Charpy tests. Calibration of the model for two additional heat treatments of A533B-1 steel is in progress.

37651 (WAPD-TM—1320) **Low strain diameter expansion of internally pressurized Zircaloy-4 tubing at high temperatures (LWBR Development Program).** White, L.S.; Busby, C.C. (Bettis Atomic Power Lab., West Mifflin, Pa. (USA)). Mar 1978. Contract EY-76-C-11-0014. 38p. Dep. NTIS, PC A03/MF A01.

Tests of closed-end, internally pressurized, Zircaloy-4 tubing specimens were utilized to develop low strain creep characteristics as a function of time at temperatures in the range of 1475°F to 2000°F (802°C to 1093°C) and hoop stresses in the range of 250 to 2500 psi for use in loss-of-coolant accident (LOCA) analyses. The strain rate above the start of the alpha to beta phase transformation region, approximately 1490°F (810°C), was found to be sensitive to the test procedure (stress-temperature history). This is believed to result from variations in the metallurgical structure. A prediction model is presented which provides a conservative upper bound to the low strain test data provided in this report and reported in the literature.

37652 **Crack propagation in cold-worked austenitic stainless steel at elevated temperatures.** Shahinian, P. (Naval Research Lab., Washington, DC). *Nucl. Technol.;* **38**: No. 3, 415-426(May 1978).

Fatigue and creep crack propagation in 20 and 25% cold-worked Type 304 and 20% cold-worked Type 316 stainless steels were examined at 427 to 593°C (800 to 1100°F). The resistance to fatigue crack growth was slightly better for Type 304 stainless steel compared to Type 316 stainless steel, and was improved by an increase in cold work; however, these differences were small. Compared to solution-annealed stainless steel, the cold-worked steels had higher crack growth resistance at high stress intensity levels. Creep crack growth occurred at 482°C (900°F), but much higher stress intensities, K, were required than in fatigue. However, at 593°C creep and fatigue crack growth occurred over the same K range and, in fact, at higher K levels crack growth in creep was faster than in fatigue. Retardation of crack growth was observed when the load on a specimen was changed from cyclic to static.

37653 **Determination of elastic coefficients for Zircaloy-2.** Catlin, W.R.; Lord, D.C.; Zaverl, F.; Lee, D. (General Electric Co., Schenectady, N.Y. (USA). Research and Development Center). *J. Nucl. Mater.;* **68**: No. 3, 345-347(Nov 1977).

Two methods for the determination of the elastic constants of Zircaloy-2 sheets are described. One method is based on the use of pole figure data to compute the elasticity coefficients and the other involves mechanical testing of the specimens.

37654 **Heat treatment effects on the tensile properties of annealed 2.25 Cr - 1 Mo steel.** Klueh, R.L. (Oak Ridge National Lab., Tenn. (USA)). *J. Nucl. Mater.;* **68**: No. 3, 294-307(Nov 1977).

The effect of heat treatment on the tensile properties of annealed 2.25 Cr - 1 Mo steel was investigated. Detailed tensile properties were determined from 25 to 593°C and strain rates between 2.67 x 10^{-6} and 6.67 x 10^{-3}/s on steel plates (from a single heat) given three different heat treatments. For all heat treatments, dynamic strain-aging peaks were observed between 200 and 400°C. The peak height for the annealed material that was cooled fastest was largest and occurred at the highest temperature. The dynamic strain aging was concluded to be the result of interaction solid solution hardening in the proeutectoid ferrite and involves interactions between molybdenum and carbon atoms or atom clusters with

dislocations. The difference in the dynamic strain-aging effects for the different heat treatments was explained in terms of the precipitation reactions that occur during the heat treatment.

37655 Technique for measuring load-line displacements of compact ductile fracture toughness specimens at elevated temperatures. Mills, W.J.; James, L.A.; Williams, J.A. (Westinghouse Hanford Co., Richland, WA). *J. Test. Eval.;* **5**: No. 6, 446-451(Nov 1977).

A test method developed for measuring load-line displacements in compact ductile fracture toughness (J/sub Ic/) specimens at elevated temperatures was used to characterize the elastic-plastic (J integral) fracture response of Inconel X-750 at 75°F (24°C) and ASME SA-387 Grade C steel at 75°F (24°C) and 600°F (316°C). This technique employs a rigid fixture, attached directly to the test specimen, which translates the load-line displacements outside the loading clevises where the displacements are monitored by two linear variable differential transformers (LVDT) inside the elevated temperature environment. To evaluate the proposed displacement measuring technique, displacements and values of J determined by the LVDT method were compared with those determined by the conventional clip gage method. The data obtained from the two displacement measuring techniques were in agreement. In addition, LVDT-determined displacements within the linear-elastic regime were consistent with theoretical displacements.

37656 Strength dependence on porosity for R/M compacts. German, R.M. (Sandia Labs., Livermore, CA). *Int. J. Powder Metall. Powder Technol.;* **13**: No. 4, 259-266, 268, 270-271(Oct 1977).

The strength of controlled porosity metallic microstructures is examined in detail. A characteristic density dependence on compaction pressure is established for powders which consolidate by a plastic deformation mechanism. Data for Ta, Fe, Al, Ti, Cu, Ni, and 304L stainless steel powder compacts substantiate an approximate power relation between strength and density. For spherical powders, it is shown that the strength is inversely dependent on the particle size. 11 figures.

37657 Stress-differential effect in surface oxide softening of niobium single crystals. Sethi, V.K.; Gibala, R. (Case Western Reserve Univ., Cleveland). *Scr. Metall.;* **11**: No. 7, 635-638(Jul 1977).

Results offer additional evidence of the correctness of the previously presented model for surface oxide softening. A large positive value of Δ tau, expected from the model, was observed experimentally. The pronounced serrated flow in tension but not in compression suggests that dislocation generation and motion are more difficult in compression. The small effect of prestrain on the strength in compression is also consistent with more difficult source operation than in tension. However, the existence of some oxide softening in compression illustrates that the oxide films have much the same enhancement effect on local plastic flow processes as in tension.

37658 Effects of hydrogen on internal friction and free oscillation frequency of pure iron. Smialowski, M.; Lunarska, E.; Zielinski, A. (Inst. of Physical Chemistry, Warsaw). pp 8p, Paper 2C3 of Hydrogen in metals. Volume 6. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P6.

Hydrogen dissolved in high-purity iron reduces internal friction and pendulum frequency. These fully reversible effects do not occur in the presence of impurities. It is concluded that hydrogen decreases the modulus of elasticity and the lattice cohesion energy of iron. 5 figures.

37659 X-ray measurement of lattice residual strains produced by hydrogen diffusion in a 0.09% carbon steel. Pathiraj, B.; Vasudevan, R. (Indian Inst. of Tech., Madras). pp 5p, Paper 2C9 of Hydrogen in metals. Volume 6. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P6.

Investigations on the effect of hydrogen diffusion by cathodic charging at various charging conditions on a 0.09% carbon steel indicated primarily two opposing effects: stress relief due to specimen surface heating, and increase in strain due to hydrogen diffusion by plastic deformation. 3 figures.

37660 Measurement of hydrogen induced lattice strain of Fe—Ni alloy crystals by x-ray diffraction. Kamachi, K.; Akiyoshi, K.; Hayashi, H. (Yamaguchi Univ., Tokivadai, Japan). pp 9p, Paper 2C13 of Hydrogen in metals. Volume 6. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P6.

The lattice strains induced by hydrogen charging in single crystals of Fe—Ni alloys were measured by the divergent x-ray method. This method is not only a precise method to determine the lattice parameters, but, in the case of hydrogen, it was able to study the crystal state before hydrogen escaped from the specimen. It became evident that the principal strains caused by hydrogen charging lie in the [100], [010], and [001] axes. The shear stresses acting on the slip plane (111) of austenite were large enough to produce the martensite phase by transformation. 9 figures, 6 tables.

37661 Study of niobium—hydrogen alloys by internal friction measurements. Ferron, G.; Quintard, M.; DeFouquet, J. (CNRS, Poitiers, France). pp 4p, Paper 2C16 of Hydrogen in metals. Volume 6. Elmsford, NY; Pergamon Press Inc. (1977). (In French)

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P6.

Internal friction measurements performed between 90 and 350 K in niobium showed different effects associated with the presence of hydrogen. Very precise information on hydrogen content and distribution are provided by examination of these effects. 4 figures.

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 37032, 37626, 37633, 37634, 37659, 37718, 38558, 38698

37662 (LBL—6016, pp 170-232) **Materials chemistry.** 1976.

In Materials and Molecular Research Division annual report, 1976.

Materials chemistry research activities in solid state physics at Lawrence Berkeley Laboratory during 1976 are described. Topics covered include: chemical structure; and high temperature and surface chemistry. (GHT)

37663 (ORNL/TM—5493/R1) **System for vacuum pouring of epoxy tensile and impact specimens with a study of the behavior of these specimens at 77 K and 293 K.** Fitzpatrick, C.M.; Stoddart, W.C.T. (Oak Ridge National Lab., Tenn. (USA)). 31 Mar 1978. Contract W-7405-ENG-26. 17p. Dep. NTIS, PC A02/MF A01.

The purpose of the investigation was to establish a suitable technique for vacuum pouring of epoxy test specimens and to study the behavior of these specimens at 77 K and 293 K. A series of tensile and impact tests was conducted using specimens made from the following resins: Epon 828, Epon 871, and Epon curing agent Z. These materials are of general interest to designers of magnets for cryogenic service. Tests of the specimens were carried out at 77 K and 293 K. The 77 K data indicate that tensile strength increases proportionally with the increase of Epon 871 relative to Epon 828. When the mixture includes more than 90% Epon 871, impact testing at 293 K becomes practically impossible due to the rubbery condition of the material. However, when tested at 77 K, this same mixture evinces high tensile strength. When optimum data are sought over a wide range of temperatures, 77 K to 293 K, it appears that a mixture of 70% Epon 871, 30% Epon 828 with 13 pph of curing agent Z or 50% Epon 871, 50% Epon 828 with 15 pph curing agent Z offers the best compromise in tensile strength, modulus of elasticity, and impact resistance.

37664 (UCRL—52375) **Measuring and predicting the dynamic effects of a confined thin metal plate pulse heated into the liquid-vapor regime.** Baxter, R.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 31 Dec 1977. Contract W-7405-ENG-48. 159p. Dep. NTIS, PC A08/MF A01.

Thesis.

The dynamic response of a confined thin layer of lead heated rapidly and uniformly to a supercritical state was investigated. Lead targets 0.025 mm and 0.05 mm thick were contained between a thin titanium tamping layer and a thick layer of fused quartz with several different gap widths between the lead and the confining surfaces. After being heated by an electron beam for about 50 ns, lead specimens expanded to a state of approximately half liquid and half vapor. Measurements of the stress in the quartz and the velocity of the tamper produced by the expanding lead were compared with one dimensional hydrodynamic computer program predictions. Measured and predicted peak stresses in the quartz for no gaps were approximately 12 kilobars and agreed within one kilobar. Peak stresses decreased rapidly with gap size to values, at 0.02 mm gaps, of about one kilobar for the 0.025 mm lead targets and five kilobars for the 0.05 mm targets. These values were confirmed by measurements. Predictions and measurements of tamper velocity (momentum) were within 10% only when the lead and confining walls were in close contact. The observed velocities for even very small gaps were substantially below predictions. These differences are attributed primarily to separation of the liquid and vapor phases during the expansion.

37665 Stress-induced enhancement of T/sub c/ in bronze-processed V_3Ge. Bussiere, J.F.; Onishi, T.; Welch, D.O.; Suenaga, M.

(Brookhaven National Laboratory, Upton, New York 11973). *Appl. Phys. Lett.;* **32**: No. 10, 686-688(15 May 1978).

Compressive stresses arising from differential contraction of the bronze matrix were found to cause an increase in the critical temperature, T/sub c/, of bronze-processed V_3Ge. This unusual behavior for an A-15 compound is in qualitative agreement with Testardi's theory, although the enhancement of T/sub c/ does not increase parabolically with strain and saturates at strains of ~0.5%.

37666 Diffusion of positive muons in vanadium. Fiory, A.T.; Lynn, K.G.; Parkin, D.M.; Kossler, W.J.; Lankford, W.F.; Stronach, C.E. (Bell Laboratories, Murray Hill, New Jersey 07974). *Phys. Rev. Lett.;* **40**: No. 14, 968-971(3 Apr 1978).

At low temperatures the muon jump rate is nearly linear in temperature for vanadium. This result provides evidence of one-phonon-assisted tunneling in the presence of impurity-induced lattice strains. A local maximum is observed in the depolarization rate near 80 K, which can be explained in a model of diffusion to impurity traps at higher temperatures.

37667 Electronic and lattice properties of V_3Hf/sub 1-x/Ta/sub x/ C-15 superconductors. Hafstrom, J.W.; Knapp, G.S.; Aldred, A.T. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., B;* **17**: No. 7, 2892-2900(1 Apr 1978).

The heat capacities and magnetic susceptibilities chi (T) of the C-15 compounds V_2Hf/sub 1-x/Ta/sub x/ (T/sub c/ = 9-10 K), with x = 0.0-0.2, and V_2Ta (T/sub c/ = 3.6 K) have been measured between 1 and 350 K. Samples with $x < 0.1$ exhibit a heat-capacity anomaly indicative of a structural transformation. The geometric mean phonon frequencies ω/sub g/(T) were evaluated for these compounds and found to decrease monotonically with increasing chi (T) independent of temperature or composition. The high-temperature lattice properties of these materials and the presence or absence of a lattice transformation are explained in terms of the magnitude of their electronic density of states N/sub d/(E/sub F/) in the cubic phase. Strong electron-phonon coupling in the ternary compounds leads to large shifts in ω/sub g/(T) and, in some cases, to a structural transformation. The narrow range of T/sub c/ values for the ternary compounds occurs because their low-temperature lattice and electronic properties are similar, independent of whether or not a structural transformation has occurred.

37668 Structure and properties of metallic glasses. Chaudhari, P. (IBM Watson Research Center, Yorktown Heights, NY); Turnbull, D. *Science;* **199**: No. 4324, 11-21(6 Jan 1978).

Recent experience has shown that certain metal alloys can be put into glass form by rapid melt-quenching or by various condensation processes. Models for the nature and structure of these glasses are surveyed and shown to be quite parallel to those already developed for the more common nonmetallic glasses. The rather unique magnetic, superconducting, and mechanical properties and the technical potential of metallic glasses are also discussed.

37669 High-frequency characteristics of superconducting films. Bagdasarov, K.S.; Braginskii, V.B.; Zubietov, P.I. (Institute of Crystallography, Academy of Sciences of the USSR, Moscow). *Sov. Tech. Phys. Lett. (Engl. Transl.);* **3**: No. 10, 406-407(Oct 1977).

It is pointed out that superconducting films may be studied by measuring the Q of a superconducting resonator covered by the film. This method is applied to lead films.

37670 Electron spin resonance on localized magnetic states in the super-conducting system La-Er. Alekseevskii, N.E.; Garifullin, I.A.; Kochelaev, B.I.; Kharakhash'yan, E.G. (Kazan' Physicotechnical Institute of the Kazan' Branch of the USSR Academy of Sciences). *Sov. Phys. - JETP (Engl. Transl.);* **45**: No. 4, 799-804(Apr 1977).

Electron spin resonance on the localized magnetic moments of Er in La in the normal and superconducting state is investigated. A strong narrowing of the resonance line following the superconducting transition is observed. We separate the contribution made to the ESR lines by the inhomogeneous distribution of the magnetic field H in a sample whose state is mixed at H/sub c1/< or =H< or =H/sub c2/. The results are interpreted on the basis of the premise that the conditions for the "electron bottleneck" in indirect exchange interactions become enhanced on going to the superconducting state.

37671 Magnetic properties of certain terbium alloys with CsCl structure. Basha, A.F.; Chechernikov, V.I.; Sinanyan, L.G.; Tavansi, A. (Moscow State University). *Sov. Phys. - JETP (Engl. Transl.);* **45**: No. 4, 808-809(Apr 1977).

The magnetic properties are investigated of solid solutions of the systems TbCu/sub 1-x/B/sub x/ (B=Ag, Zn, Al). When the copper atoms are replaced by zinc and aluminum atoms, the Neel temperature is lowered and the magnetic Curie temperature Θ/sub p/ reverses sign at 16 at.% Al and 24 at.% Zn, with Θ/sub p/>0 for alloys with larger contents of these metals, i.e., the configuration changes from antiferromagnetic to ferromagnetic. The antiferromagnetism is preserved in the solid solution TbCu/sub 0.5/Ag/sub 0.5/. The results are interpreted on the basis of the RKKY theory.

37672 Removal of dissolved hydrogen in liquid iron. Ogunleye, A. (Univ. of Ife, Nigeria). pp 9p, Paper 1F6 of Hydrogen in metals. Volume 7. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P7.

Molten iron saturated with different gases was dicharged through different nozzles into an evacuated chamber. The streams were photographed and its discharge coefficient was measured. The break-up intensity of hydrogen-saturated streams varied with availability of suitably sized pores for gas bubble nucleation.

37673 Gas release from crystalline systems. Katz, Y.; Shai, I.; Lanxner, M.; Mathias, H. (Nuclear Research Centre, Beer Sheva, Israel). pp 9p, Paper 1F8 of Hydrogen in metals. Volume 7. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P7.

Gas release from crystalline systems was investigated at room temperature. Particularly, ^{3}He release from UT_3 due to radioactive decay was examined. Results concerning H_2 release from Fe after cathodic charging are included. Discussion is provoked regarding geometrical and mechanical factors.

37674 Solubility of deuterium in, and its separation from, liquid lithium by distillation. Ihle, H.R.; Wu, C.H. (KFA, Juelich, Ger.). pp 8p, Paper 1D8 of Hydrogen in metals. Volume 7. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P7.

The solubility of deuterium in liquid lithium was determined by Knudsen effusion mass spectrometry. Li_3, Li_2D, LiD_2, and Li_2D_2 were found as new molecules; their atomization energies and the binding energies of their respective positive ions were determined. Rayleigh distillation experiments independently verified the results. 4 figures, 3 tables.

37675 Hydrogen in metals. Volume 6. Elmsford, NY; Pergamon Press Inc. (1977). 190p. (In French and English). (CONF-770613—P6).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

A separate abstract was prepared for each of the 26 papers in this volume. (RWR)

37676 Diffusion coefficient of hydrogen in niobium. Mazzolai, F.M.; Franco, R. (CNR, Rome). pp 6p, Paper 2C1 of Hydrogen in metals. Volume 6. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P6.

The diffusion coefficient, D, of hydrogen in pure and oxygen-doped niobium was determined as a function of temperature by means of the Gorsky relaxation effect. The existence of a deviation of D from an exponential behavior at low temperatures was confirmed. 3 figures, 1 table.

37677 Question of a hydrogen relaxation in iron at low temperature. Dufresne, J.F.; Ritchie, I.G.; Moser, P. (CEN, Grenoble, France). pp 8p, Paper 2C4 of Hydrogen in metals. Volume 6. Elmsford, NY; Pergamon Press Inc. (1977). (In French)

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P6.

In high-purity iron, important phenomena attributable to the movement of Bloch walls in the temperature range 1.6 to 80°K bring into question the interpretation of magnetic aftereffect zones and peaks of internal friction in the temperature range previously attributed to the relaxation of isolated hydrogen interstitials. 4 figures.

37678 De Haas-Van Alphen effect in palladium-hydrogen alloys. Griessen, R. (Vrije Univ., Amsterdam); Venema, W.J.; Jacobs, J.K.; Manchester, F.D. pp 7p, Paper 2C7 of Hydrogen in metals. Volume 6. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P6.

From de Haas—van Alphen investigations of palladium—hydrogen alloys it is found that at low concentrations the added hydrogen electrons do not fill the palladium d-bands.

37679 Diffuse x ray scattering from the displacement field of hydrogen in Nb and Ta. Metzger, T.H. (Univ. of Houston, TX); Peisl,

J. pp 6p, Paper 2C8 of Hydrogen in metals. Volume 6. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P6.

The strength and the symmetry of the displacement field of H in Nb and Ta was measured by means of diffuse x ray scattering close to the reciprocal lattice points of type (hh0). The double force tensor P/sub ij/ = delta/sub ij/ 3.37eV and P/sub ij/ = delta/sub ij/ 3.54 eV was determined for hydrogen in Nb and Ta, respectively.

37680 Post ,charging events in hydrogenerated austenitic steels. Mathias, H. (Nuclear Research Centre-Negev, Beer Sheva, Israel); Katz, Y.; Nadiv, S. pp 8p, Paper 2C11 of Hydrogen in metals. Volume 6. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P6.

Post charging events in austenitic steels were investigated utilizing electrolytic hydrogen charging in ausformed metastable and commercial stainless steels. Hydrogen release, microstructural changes, cracking and mutual interaction, including plastic zone effects, were studied. Dynamic aspects related to charging events are discussed. 5 figures.

37681 Influence of the crystalline structure of nickel films on hydrogen electrochemical adsorption or absorption. Angely, L.; Bronoel, G.; Peslerbe, G. (CNRS, Meudon-Bellevue, France). pp 5p, Paper 4A1 of Hydrogen in metals. Volume 6. Elmsford, NY; Pergamon Press Inc. (1977). (In French)

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P6.

The amounts of hydrogen included in the lattice or adsorbed at the surface are measured by potentiostatic charging curves. These phenomena depend on the crystalline structure of the Ni films obtained by vacuum deposition. 1 figure, 2 tables.

37682 Investigation of the effect of palladium on steel permeability to hydrogen. Chigirinskaya, L.A.; Chernova, G.P.; Tomashov, N.D. (Inst. of Physical Chemistry, Moscow). pp 7p, Paper 4A2 of Hydrogen in metals. Volume 6. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P6.

It was demonstrated that modification of the surface of Y8A or Y8A 0.5% Pd carbon steels by palladium from the solution (for the Y8A) or alloy (for the Y8A 0.5% Pd) can be used for reduction of steel hydrogenation in conditions of cathodic polarization and etching in acid solution. 4 figures, 1 table.

37683 Improved electropermeation technique for studying hydrogen transport in metals. Heidersbach, R.; Jones, J.; Surkein, M. (Univ. of Rhode Island, Kingston). pp 10p, Paper 4A3 of Hydrogen in metals. Volume 6. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P6.

An electrochemical hydrogen permeation cell for metals, incorporating improved geometrical and other design features, was developed and tested. Results indicate a need for palladium coating on entry and exit surfaces. Coating problems are discussed. 4 figures, 2 tables, 52 references.

37684 Hydrogen entry into alloys from high temperature water. Mayer, P.; Dautovich, D.P. (Ontario Hydro, Toronto). pp 8p, Paper 4A10 of Hydrogen in metals. Volume 6. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P6.

A novel technique utilizing ion pumps was developed and used to measure hydrogen permeation from dry gaseous environment and high-temperature water (pH = 10) into 403 SS, 405 SS, Inconel 600 and Sanicro 30. 9 figures, 3 tables.

37685 Comparative hydrogen permeation studies of aluminium alloys exposed to water vapor. Tuck, C.D.S.; Scamans, G.M. (Alcan Labs. Ltd., Banbury, Eng.). pp 8p, Paper 4A11 of Hydrogen in metals. Volume 6. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P6.

AlZnMg alloys allow hydrogen permeation on exposure to water vapor at 70°C, whereas pure aluminum and AlMgSi alloys do not. This behavior is due to the localization of hydrous film growth at grain boundary/surface intersections. 9 figures.

37686 Investigation of the hydrogen sorbed on the surface of skeleton catalysts. Heiszman, J.; Bekassy, S.; Tungler, A.; Petro, J. (Technical Univ., Budapest). pp 8p, Paper 4A13 of Hydrogen in metals. Volume 6. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P6.

Studies on skeleton nickel catalysts belonging to different types were carried out by applying a variety of methods. From the data obtained, conclusions were drawn on the relationship between the hydrogen content, structure, and catalytic properties of the active catalysts. 4 figures, 3 tables.

37687 Hydrogen and deuterium in iron, 9--73°C. Kumnick, A.J.; Johnson, H.H. (Cornell Univ., Ithaca, NY). *Acta Metall.;* **25**: No. 8, 891-895(1977).

The permeabilities, solubilities and effective diffusivities of hydrogen and deuterium in iron were measured over 9 to 73°C by the electrochemical technique. The permeation activation energies for hydrogen and deuterium were essentially equal at 8360 +- 610 and 8570 +- 780 cal/mol, respectively. The solubilities of the two isotopes were also equal. Evaluation of the steady state fluxes and the effective diffusivities indicates an isotopic effect of 1.8 +- 0.2, measurably greater than the classical ratio of 1.41. 8 figures, 2 tables.

37688 Application of polarized positive muons in solid state physics. Schenck, A. (Laboratorium fuer Hochenergiephysik, Zurich). pp 159-297 of Nuclear and particle physics at intermediate energies. Warren, J.B. (ed.). New York; Plenum Press (1976).

From Proceedings of the advanced study institute in nuclear and particle physics at intermediate energies; Victoria, B.C., Canada (Jun 1975).

See CONF-7506100—.

The principles and various types of muon spin rotation, relaxation, research, etc. experiments, the types of magnetic interactions of the muon, and related phenomena like spin—spin relaxation and motional narrowing are treated. Then muon diffusion, charge screening of positive muons in metals and, in some depth, the possibilities of muon spin rotation for studying magnetic problems are considered. Lastly the behavior of muonium in solids is discussed. 111 references. (JFP)

37689 (BNWL-tr—305) **Electrical resistivity of thin copper films vapor-coated under different residual gas pressures.** Rudolf, P.; Wissmann, P. Translated from *Vak.-Tech.;* **25**: No. 8, 242-247(1976). 14p. Dep. NTIS, PC A02/MF A01.

Portions of document are illegible.

Polycrystalline and monocrystalline copper films are deposited on Si (111) foundations under different residual gas pressures, and the film thickness dependence of electrical resistance is measured. In an evaluation by means of the path length theory, negative values evolve for the Fuchs scatter parameter p, especially in the case of high residual gas pressures. This effect is attributed to a partial incorporation of the residual gas into the metal lattice and the related increase in crystal boundary scattering.

37690 (RFP-Trans—239) **Solubility of phosphorus in α- and γ-iron.** Kaneko, H.; Nishizawa, T.; Tamaki, K.; Tanifuji, A. Translated from *J. Jpn. Inst. Met.;* **29**: No. 2, 166(1965). 11p. Dep. NTIS, PC A02/MF A01.

According to the Fe—P phase diagram, the solubility of phosphorus in α—Fe at 1050°C is known to be 2.8 wt %. This value is extremely large compared with the amount of phosphorus found in commercial steel. Therefore, it has been supposed that phosphorus in steel might dissolve in the matrix, and any phosphide phases such as phosphide-inclusions or phosphide-precipitations might not be present at all. However, it has been confirmed in the present research that the solubility of phosphorus in α and γ-iron is remarkably decreased by the alloying of phosphide forming elements. From this experiment it should be concluded that phosphide phases are present in commercial steels containing the strong phosphide forming elements and in some cases, the phosphide-precipitation takes place, which is expected to play an important role in aging phenomena such as the temper-brittleness of alloy steels.

CORROSION AND EROSION

REFER ALSO TO CITATION(S) 37041, 37268, 37343, 37390, 37680, 37685, 38387

37691 (COO—2354-5) **Cluster carburizing. Progress report, June 1, 1977—May 31, 1978.** Morral, J.E. (Connecticut Univ., Storrs (USA)). Feb 1978. Contract EY-76-S-02-2354. 11p. Dep. NTIS, PC A02/MF A01.

When aging quenched Ta-27% Hf alloys at 685°C, excess thermal vacancies were found to condense into vacancy loops. The loops are responsible for the first age-hardening peak observed during heat treatment. In a study of binary alloys formed by two

monocarbides, a miscibility gap was found in the NbC-HfC system with a critical temperature between 1100—1200°C, while homogeneous solutions were formed by TaC-HfC down to 1000°C. An investigation of solid phase carburizing of Ta-Hf and Nb-Hf alloys indicated that this technique results in a higher carbon activity, but slower kinetics than was obtained by gas carburizing. Work continues on improving this technique and on preparing cluster carburized specimens for study by transmission electron microscopy.

37692 (DP-MS—77-86) **Mechanism for hydrogen-induced brittle fracture of austenitic stainless steels.** Caskey, G.R. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). 1978. Contract EY-76-C-09-0001. 17p. (CONF-780213—1). Dep. NTIS, PC A02/MF A01.

From 107. AIME meeting; Denver, CO, USA (26 Feb 1978).

Internal hydrogen embrittlement of several austenitic stainless steels is known to be accompanied by a change in fracture mode. Type 304L stainless steel is representative of these alloys. In other austenitic stainless steels, Type 310 for example, no change in fracture mode has been reported and gas phase charging of the alloy causes little change in strength or ductility. Cathodic charging, however, introduces extremely large amounts of hydrogen and ductility losses are observed. The embrittlement mechanism proposed in this paper for Type 304L stainless steel and similar alloys is based on results of a continuing program to investigate hydrogen embrittlement of austenitic stainless steels. The proposed mechanism, therefore, is tentative insofar as future results may contradict current beliefs or permit a more definitive mechanism to be developed. One central notion of this proposal is that of microcrack formation. The present fracture model envisions the nucleation step as taking place via a Zener—Stroh—Petch mechanism rather han a Cottrell coalescence model as proposed by Blanchard and Troiano.

37693 (HEDL-TME—77-71) **In-sodium corrosion behavior of candidate commercial fuel cladding and duct alloys.** Shiels, S.A.; Keeton, A.R.; Anantatmula, R.P. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Feb 1978. Contract EY-76-C-14-2170. 39p. .

Several commercial alloys are under consideration for future breeder reactor fuel cladding and duct applications. One of the performance criteria for these applications is resistance to sodium corrosion. This report covers the in-sodium corrosion testing of these alloys. The alloys were tested in three corrosion facilities at three different laboratories. Two of the systems were very similar in design while the third differed principally in its capability to achieve high heating rates comparable to those obtained with fuel pins. Test conditions were 700°C, 4.8 and 6 m/s sodium velocity and approximately 1 ppM oxygen. Alloy behavior was evaluated by measuring weight loss rates; recognizing that phenomena such as subsurface degradation and intergranular attack could influence the final ratings. The effects of alloy nickel content, heating rate, corrosion rate, and the importance of downstream effect on data evaluation are discussed.

37694 (ORNL—5373) **Oxidation of heated 2¼ Cr—1 Mo steel tubing in flowing superheated steam.** Griess, J.C.; DeVan, J.H.; Maxwell, W.A. (Oak Ridge National Lab., Tenn. (USA)). Apr 1978. Contract W-7405-ENG-26. 42p. .

Tests were performed to determine the effect of a high heat flux on the corrosion behavior of 2¼ Cr-1 Mo steel in superheated steam. The purpose was to compare the effects of heat flux on oxidation when steam was exposed to either the inner or outer tube surface. All heat-flux tests were conducted at a heat flux of 126 kW/m² (40,000 Btu/hr.ft²) across the corroding surface and used steam from the superheater circuit of a commercial oil-fired power plant. Both air-melted and vacuum-arc-remelted (VAR) steels were studied. Tests with the VAR steel at surface temperatures of 502 to 522°C (936 to 972°F) and heated from the inside showed that for times as long as 10,000 hr the corrosion rate constantly decreased (approximating a parabolic rate law), even though slight oxide exfoliation occurred after 6000 hr. Specimens of air-melted and VAR steels were exposed isothermally at 503°C (938°F) in the same test and showed different corrosion rates from the heat-transfer specimens, but the rates did not differ with melting practice. In a final test in which internally and externally heated specimens were exposed to steam under identical conditions (510 to 541°C) the oxide formed on the inside of tabular specimens showed as great a tendency to exfoliate as that formed on the outside surfaces. In all cases the oxides formed under heat flux conditions were porous, cracked, and poorly attached to the metal substrate. As a result, exfoliation occurred early in the test and resulted in enhanced corrosion. Internally heated VAR and air-melted steels showed identical corrosion rates and exfoliation tendencies.

37695 (SAAS—219) **Corrosion behavior of Zr-1 wt% Nb cladding tubes for nuclear fuel elements.** Richter, K.J. (Staatliches Amt fuer Atomsicherheit und Strahlenschutz, Berlin (German Democratic Republic)). 1977. 22p. (In German). Dep. NTIS (US Sales Only), PC A03/MF A01.

A short review is presented concerning the corrosion behavior of zirconium-base cladding materials, especially Zr-1 wt% Nb, in gaseous media and its relevance to the safe transport of spent fuel elements.

37696 (SAND—78-0439) **Stress corrosion cracking of uranium—niobium alloys.** Magnani, N.J. (Sandia Labs., Albuquerque, N.Mex. (USA)). Mar 1978. Contract EY-76-C-04-0789. 33p. Dep. NTIS, PC A03/MF A01.

The stress corrosion cracking behavior of U-2¼, 4½, 6 and 8 wt % Nb alloys was evaluated in laboratory air and in aqueous Cl^- solutions. Thresholds for crack propagation were obtained in these environments. The data showed that Cl^- solutions are more deleterious than air environments. Tests were also conducted in pure gases to identify the species in the air responsible for cracking. These data showed the primary stress corrodent is water vapor for the most reactive alloy, U-2¼% Nb, while O_2 is primarily responsible for cracking in the more corrosion resistant alloys, U-6 and 8% Nb. The 4½% alloy was found to be susceptible in both H_2O and O_2 environments.

37697 **Determination of embrittling hydrogen in iron and steel by gas-chromatography.** Brule, B. (Laboratoire Central des Ponts et Chaussees, Paris); Cornet, M.; Talbot-Besnard, S. pp 8p, Paper 1F1 of Hydrogen in metals. Volume 7. Elmsford, NY; Pergamon Press Inc. (1977). (In French)

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P7.

Embrittling hydrogen in iron and steels, diffusible at moderate temperatures, is evolved by heating the sample up to 450°C, in a closed vessel filled with air under atmospheric pressure. A part of the mixture obtained is analyzed gas-chromatographically. 4 figures, 2 tables.

37698 **Quantitative method for estimation of steel susceptibility to flakes.** Goltsov, V.A.; Kusin, A.P.; Muradova, R.G.; Zakharov, V.A. (Donetsk Polytechnical Inst., USSR). pp 6p, Paper 1F9 of Hydrogen in metals. Volume 7. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P7.

A quantitative technique for determination of steel susceptibility to flakes is described. The results of flake formation study in IOXCHD steel as a function of sample diameter and cooling after saturation up to different hydrogen amounts are summarized. The influence of metallurgical factors on flake formation in I8X2H4BA steel is studied. 4 figures, 1 table.

37699 **Morphology of hybride in cold-worked Zr—2.5 Nb.** Mayer, P.; Simpson, C.J. (Ontario Hydro, Toronto). pp 6p, Paper 1D5 of Hydrogen in metals. Volume 7. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P7.

The morphological development of hydrides in cold-worked Zr—2.5 Nb saturated with hydrogen was investigated. Electrolytically hydrided coupons were subjected to isothermal and thermal cycling anneals. A considerable difference in hydride morphology was observed. The results were theoretically interpreted with the aid of the phase rule. 7 figures, 1 table.

37700 **Internal friction evolution of a hydrogened martensitic structure. Embrittlement description.** Carrard, M.; Plusquellec, J.; Azou, P.; Bastien, P. (Ecole Centrale des Arts et Manufactures, Chatenay-Malabry, France). pp 7p, Paper 2C2 of Hydrogen in metals. Volume 6. Elmsford, NY; Pergamon Press Inc. (1977). (In French)

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P6.

A qualitative analysis of the internal friction behavior of an Fe—Ni—C martensitic structure in a tempered and hydrogen-charged state is presented. There appears an anomalous displacement of the cold work peak in relation to nonreversible brittleness. 5 figures.

37701 **Influence of hydrogen on internal friction in annealed or cold-worked titanium.** Besse, S.; Quintard, M.; Mazot, P.; Petit, J. pp 6p, Paper 2C17 of Hydrogen in metals. Volume 6. Elmsford, NY; Pergamon Press Inc. (1977). (In French)

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P6.

Embrittlement of titanium is related to the presence of hydrogen. Internal friction measurements showed a possibility of evaluating the hydrogen content with distinction between the different states (interstitial or precipitates). They have also shed light on the dislocation—hydrogen interaction mechanism. 4 figures, 3 tables.

37702 Influence of electrolytic cadmium and chromium plating on the content of hydrogen in a high-strength steel and methods for controlling the embrittlement. Schmitt-Thomas, K.G.; Wollrab, P.M.; Hoffmeister, B. Dueck, M. (Technische Univ., Munich). pp 6p, Paper 4A5 of Hydrogen in metals. Volume 6. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P6.

A low-alloy steel was electrolytically plated with cadmium and chromium. The concentration of hydrogen was measured quantitatively. The embrittlement by hydrogen could be tested by means of several methods: slow bending test, tensile test, creep strength test, acoustic emission. 1 figure.

37703 Influence of mechanical surface treatment on hydrogen embrittlement of a high-strength steel. Schmitt-Thomas, K.G.; Wollrab, P.M.; Hoffmeister, B. (Technische Univ., Munich). pp 11p, Paper 4A6 of Hydrogen in metals. Volume 6. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P6.

Three different surfaces were produced mechanically by grinding, sandblasting, and shotpeening and were electrolytically charged with hydrogen. These surfaces were investigated by SEM for topographic properties. The state of residual stress at the surfaces was studied by means of x-ray-diffraction. 15 figures.

37704 Hydrogen-induced cracking of line pipe steel under wet hydrogen sulfide environment. Ikeda, A.; Morita, Y.; Terasaki, F.; Takeyama, M. (Sumitomo Metal Ind., Ltd., Amagasaki, Japan). pp 8p, Paper 4A7 of Hydrogen in metals. Volume 6. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P6.

Hydrogen-induced cracking (HIC) of line pipe steels under wet hydrogen sulfide environment was investigated. The influence of metallurgical factors and external stress on HIC susceptibilities is reported. The morphology and developing process of HIC are also discussed by the stress and strain analysis around the cracks. 16 figures, 1 table.

37705 Sulfide stress cracking tests on C 95 and N 80 casing and tubing. Comparison of results. Blanchard, F.; Sourdillon, D. (Centre d'Etudes Vallourec, Aulnoye-Aymeries, France). pp 6p, Paper 4A9 of Hydrogen in metals. Volume 6. Elmsford, NY; Pergamon Press Inc. (1977). (In French)

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P6.

Sulfide stress cracking tests on tubing and casing in Cr—Mo and Cr—Mo—Si steel, C 95 grade, are reported. These results are compared with those obtained on N 80 tubes successfully used at Lacq. Three sulfide stress cracking tests are used. 6 figures, 1 table.

37706 (BNWL-tr—295) **Influence of metalloid impurities of the sulfur family on the intergrannular brittleness of pure iron.** Pichard, C.; Rieu, J.; Goux, C. Translated from *Mem. Sci. Rev. Metall.;* **70**: No. 1, 13-22(1973). 27p. Dep. NTIS, PC A03/MF A01.

The problem of intergranular brittleness of iron was investigated. The influence of elements of the same family: selenium and tellurium, and the effect of oxygen were studied. Ultrahigh purity iron was employed. (GHT)

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 37278, 37282, 37817, 38697, 38702

37707 (AERE-R—8806) **Transition from gas bubble to void growth.** Hayns, M.R. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). May 1977. 64p. Dep. NTIS (US Sales Only), PC A04/MF A01.

A natural feature of the rate theory of void swelling is that it completely describes the growth of a cavity from a gas bubble through a transition growth region to a void in the presence of an evolving microstructure. We have expressed this transition from gas bubble to void growth in terms of a critical radius and shown that this is a very useful tool for interpreting the early life kinetics of void growth. As an example we have calculated the initial helium gas bubble population expected in pre-injected samples of 316 stainless steel used in simulation void swelling experiments using a sophisticated bubble nucleation and growth model. Applying the critical radius arguments to these calculated bubble size distributions we have obtained a consistent and simple interpretation of the observed void concentrations in subsequent irradiations. The implications following from these arguments for the interpretation of neutron irradiated steels is discussed.

37708 (HEDL-TME—78-3) **Updated design equation for swelling of 20% CW AISI 316 SS.** Bates, J.F.; Korenko, M.K. (comps.). (Hanford Engineering Development Lab., Richland, Wash. (USA)). Jan 1978. Contract EY-76-C-14-2170. 42p. Dep. NTIS, PC A03/MF A01.

A new equation has been developed for describing swelling in stress free 20% worked AISI stainless steel. The new expression is a function of temperature and fluence and encompasses temperature dependent functions for both the linear swelling rate of the material (The new equation utilizes the same swelling rates that were used in the previous equation.) and also the incubation parameter. An updating of the data base for this material and the rationale behind alterations of the previous design equation are discussed in detail in the report. The new relationship is designated the "Nuclear Systems Materials Handbook Mk 6 Swelling Equation for Unstressed 20% Cold Worked AISI 316" and is recommended for design applications.

37709 (IS-T—810) **Neutron irradiation effects on the mechanical properties of thorium and thorium—carbon alloy.** Wang, S.C.P. (Ames Lab., Iowa (USA)). Apr 1978. Contract W-7405-ENG-82. 72p. Dep. NTIS, PC A04/MF A01.

Thesis.

The effects of neutron exposure to 3.0 x 10^{18} neutrons/cm^2 on the mechanical properties of thorium and thorium-carbon alloy are described. Tensile measurements were done at six different test temperatures from 4°K to 503°K and at two strain rates. Thorium and thorium-carbon alloy are shown to display typical radiation hardening like other face-centered cubic metals. The yield drop phenomenon of the thorium-carbon alloy is unchanged after irradiation. The variation of shear stress and effective shear stress with test temperature was fitted to Seeger's and Fleischer's equations for irradiated and unirradiated thorium and thorium-carbon alloy. Neutron irradiation apparently contributes an athermal component to the yield strength. However, some thermal component is detected in the low temperature range. Strain-rate parameter is increased and activation volume is decreased slightly for both kinds of metal after irradiation.

37710 (SAND—77-2052) **Depth distributions of low energy deuterium implantations in (110) tungsten: a theoretical model.** Brice, D.K. (Sandia Labs., Albuquerque, N.Mex. (USA)). Mar 1978. Contract EY-76-C-04-0789. 33p. Dep. NTIS, PC A03/MF A01.

The depth distributions of 80 eV D^+ implants in (110) W have recently been measured by field desorption microscopy. Prominent structure, consisting of seven major and several minor peaks, is observed in the measured distributions. This contrasts with conventional implantation theory which predicts two peaks, one for the channeled D^+ and one for the nonchanneled D^+. The observed structure is explained in the present report by a model which ascribes the various peaks to D^+ groups which have been scattered into planar channels by the surface impurities. The model allows a determination of D^+ stopping powers in the various planar channels and the stopping power of C and O impurities which recoil down the [110] axis. The model suggests that surface location of the impurities as well as their elastic scattering cross section for D^+ projectiles could be extracted from more elaborate calculations and experiments.

37711 Assessment of reactor pressure vessel irradiated materials considerations. Stahlkopf, K.E.; Marston, T.U. (Electric Power Research Inst., Palo Alto, CA). *J. Test. Eval.;* **6**: No. 2, 108-113(Mar 1978).

Regulatory action has contributed almost 4% to the accumulated outage time of the nuclear plants. This translates into a loss of between $66 million and $280 million to the economy. Radiation-embrittlement-related regulatory actions and associated outages are predicted for the future. This paper evaluates the current regulations related to radiation embrittlement and discusses some of the current embrittlement issues. Weakness in the regulations are identified and recommendations for future research to overcome these weaknesses are presented. 7 figs., 3 tables.

37712 In-reactor stress relaxation of Inconel X750 springs. Walters, L.C.; Ruther, W.E. (Argonne National Lab., Idaho Falls, Idaho (USA)). *J. Nucl. Mater.;* **68**: No. 3, 324-333(Nov 1977).

In 1965 eight surveillance subassemblies were placed in row 12 of the EBR-II sodium-cooled fast breeder reactor with an irradiation temperature near the sodium-inlet temperature of 371°C. At the same time, two other surveillance subassemblies were placed in the

primary storage basket, which receives minimal neutron exposure but is immersed in primary sodium and experiences a temperature of 371°C. Each of the subassemblies contained 18 preloaded springs made of Inconel X750. Springs from four of the in-core subassemblies and one subassembly from the storage basket have been evaluated to determine irradiation-enhanced deformation rates to neutron exposures of 4.2 dpa. It was found that the creep coefficient derived from the stress relaxation measurements on Inconel X750 springs was 1.0×10^{-12} $(Pa\text{-}dpa)^{-1}$ for springs irradiated up to 4.2 dpa (3751 d) at an in-reactor temperature of 371°C. The relaxation behavior was adequately described by a creep law that was linear in neutron fluence and applied stress. Springs encapsulated in helium showed identical in-reactor relaxation rates to springs exposed to the flowing primary sodium. The creep coefficient derived from the present work on Inconel X750 springs was shown to be the same as the creep coefficients determined from various austenitic steel alloys.

37713 (ORNL-tr—4612) **Low temperature irradiation effects on mechanical properties of epoxy resin used in superconducting magnets.** Nishijima, S.; Okada, T. Translated by T.E. Ohtani from *Teion Kogaku;* **12**: No. 6, 224-229(1977). 14p. Dep. NTIS, PC A02/MF A01.

Superconducting magnets for fusion device are greatly influenced by the radiation environment and the principal radiation-induced trouble is to arise from the change of mechanical fracture behavior in organic materials used as insulating and/or potting materials. Small compression test specimens of epoxy resin are tested after gamma and pile irradiations at low temperature. Three kinds of mechanical properties i.e. (a) breaking stress, (b) breaking strain and (c) elastic modulus are investigated. A statistical analysis of the data from a large number of small specimens revealed the followings: (i) The effects of gamma and neutron irradiations on the fracture behaviors are observed to be different. This fact suggests that the simulation study by gamma is not safe for neutron irradiation. (ii) In the case of reactor irradiation overall softening are induced accompanied by local hardening and embrittlement. A qualitative extlanation to the above results is presented and their effect on the performance of the magnets is stated.

CERAMICS, CERMETS, AND REFRACTORIES

REFER ALSO TO CITATION(S) 37604, 37620

PREPARATION AND FABRICATION

37714 **Silicon carbide—boron carbide sintered body.** Prochazka, S.; Coblenz, W.S. (to General Electric Co.). US Patent 4,081,284. 28 Mar 1978. Filed date 4 Aug 1976. 10p.

A particulate mixture of β-silicon carbide, boron carbide, and a carbonaceous additive is formed into a green body and sintered; a sintered body with a density of at least about 85 percent containing boron carbide in an amount ranging from about 10 percent to about 30 percent by weight of the total amount of silicon carbide and boron carbide present is produced. 1 figure, 1 table.

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 37034

37715 (IS-T—804) **Determination of phase boundaries and diffusion parameters in tantalum hydrides in pulsed NMR.** Hornung, P.A. (Ames Lab., Iowa (USA)). Apr 1978. Contract W-7405-ENG-82. 114p. Dep. NTIS, PC A06/MF A01.

Thesis.

Proton spin-lattice relaxation times T_1 were measured over a wide range of temperature (77 K to 470 K) and compositions (H/Ta = 0.155 to 0.677) in the tantalum-hydrogen system at a frequency of 40,000 MHz. In the high temperature solid solution α phase, the activation energy for hydrogen diffusion was found to be 0.140 +- 0.002 eV/atom, and the value of the jump rate (or its corresponding correlation time) was found to be essentially constant throughout the range of compositions studied. The conduction electron contribution to T_1 measured in the α phase agreed qualitatively with the trend shown by previously published susceptibility data. The single phase epsilon region and the α + epsilon two-phase region were particularly noted. It could also be concluded from the measurements that the hydrogen jump rate decreased by a factor of approximately 7.2 from the α phase to the ordered phases at low temperatures and slightly decreased further in the epsilon phase. Anomalous relaxation times were found in the low temperature range (77 K less than or equal to T less than or equal to K). In this region, T_1 remains essentially constant, and does not follow the usual temperature dependence for either motional or electronic relaxation. Two possible explanations for this behavior were considered. The first involves proton cross-relaxation to the ^{181}Ta nuclei which would sample the spectral density of magnetic fluctuations in the sample at several frequencies because of the probable very strong ^{181}Ta quadrupole interaction strength. The second explanation postulates that the hydrogen diffusional jump path involves an intermediate metastable state.

37716 (LBL—6678) **High resolution techniques and application to non-oxide ceramics.** Clarke, D.R. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Oct 1977. Contract W-7405-ENG-48. 45p. (CONF-770416—4). Dep. NTIS, PC A03/MF A01.

From 79. annual meeting of American Ceramic Society; Chicago, IL, USA (23 Apr 1977).

The microstructure of ceramic materials can now be observed directly at the atomic level by using high-resolution electron microscopy. These techniques are described in detail, and the type of new information that they are revealing about the structure of ceramics is illustrated with examples drawn from investigations of hot-pressed silicon nitrides, sintered silicon carbide, and a "Sialon" system. 15 figures.

37717 **Synthesis of molybdenum nitride and carbide by nitrogen and carbon ion bombardment.** Afanas'ev, G.V.; Gverdtsiteli, I.G.; Guldamshvili, A.I.; Diasamidze, E.M.; Kalinin, A.N.; Karpenko, I.K.; Kutsiya, N.M. *Sov. Phys. - Crystallogr. (Engl. Transl.);* **22**: No. 4, 480-483(Jul 1977).

The formation of molybdenum nitride and carbide during the bombardment of polycrystalline and single-crystal molybdenum films with nitrogen and carbon ions is described. The structures of the films are established by electron microscopy and electron diffraction. In contrast to published data the formation of an anomalous fcc structure of molybdenum is not encountered, even on bombarding molybdenum films with molybdenum ions.

37718 **Hydrogen in metals. Volume 7.** Elmsford, NY; Pergamon Press Inc. (1977). 135p. (In French and English). (CONF-770613—P7).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

A separate abstract was prepared for each of the 20 papers in this volume. (RWR)

37719 **About the different structural behaviour of hydrogen and deuterium in vanadium.** Hauck, J. (Festkoerperforschung KFA, Juelich, Ger.). pp 8p, Paper 1D1 of Hydrogen in metals. Volume 7. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P7.

The substantial differences between the VH and VD phase diagrams can be related to changes of the effective charge at the H atoms with concentration, temperature, and isotope exchange. Thermodynamic data of the VH system, especially the crystal field stabilization energy are very sensitive to slight changes of the charge distribution.

37720 **TaH system: structures, phase diagram and morphologies.** Schober, T. (Festkoerperforschung KFA, Juelich, Ger.). pp 7p, Paper 1D2 of Hydrogen in metals. Volume 7. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P7.

The TaH phases are summarized. A new phase diagram based on differential thermal analysis (DTA) data is presented. Electron microscope and metallography results are described. 6 figures.

37721 **Investigations on the phase diagram of the Nb—H system.** Welter, J.M.; Pick, M.A.; Schober, T.; Hauck, J.; Fenzl, H.J.; Wenzl, H. (Festkoerperforschung KFA, Juelich, Ger.). pp 3p, Paper 1D3 of Hydrogen in metals. Volume 7. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P7.

A new phase diagram is presented for the niobium interstitial alloys of the NbH system. 1 figure.

37722 **Hydrogen (deuterium) location and tetragonal distortion in β VH/sub x/ and β V_2D.** Asano, H.; Hirabayashi, M. (Tohoku Univ., Sendai). pp 6p, Paper 1D6 of Hydrogen in metals. Volume 7. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P7.

Tetragonality of β VH/sub x/ (x = 0.4 to 0.8) and β V_2D was analyzed as a function of temperature and composition in terms of the occupation probabilities of hydrogen (deuterium) in the inter-

stitial sites. It is shown that the hydrogen atoms locate at the z-type octahedral sites in the β-phase alloys. 5 figures.

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 37500

37723 (IS-T—807) **Elastic properties of monoclinic hafnium oxide.** Dole, S.L. (Ames Lab., Iowa (USA)). Dec 1977. Contract W-7405-ENG-82. 133p. Dep. NTIS, PC A07/MF A01.

Thesis.

The elastic properties of monoclinic hafnium oxide were studied as functions of porosity, temperature and grain size. An important finding of this study was that hafnium oxide is subject to microcracking when the grain size exceeds a critical value between 2 and 3 mu m. The behavior of the elastic moduli with porosity and temperature for crack-free hafnium oxide was typical for polycrystalline ceramics. The nature of the thermal expansion and the internal friction supported this finding. The elastic properties for the microcracked material exhibited trends similar to those observed for other microcracked materials. However, some new characteristics of the microcracking effects were observed in this study. An increase in internal friction was associated with the microcrack healing process. It was also found that there is an atmospheric effect that enhances microcrack growth. Additionally, thermal treatments of microcracked hafnium oxide were found to result in significant changes in the microcrack system.

37724 (ORNL/TM—6176) **Arc-discharge system for nondestructive detection of flaws in thin ceramic coatings.** Scott, G.W.; Davis, E.V. (Oak Ridge National Lab., Tenn. (USA)). Apr 1978. Contract W-7405-ENG-26. 38p. Dep. NTIS, PC A03/MF A01.

The feasibility of nondestructively detecting small cracks or holes in plasma-sprayed ceramic coatings with an electric arc-discharge system was studied. We inspected ZrO_2 coatings 0.46 mm (0.018 in.) thick on Incoloy alloy 800 substrates. Cracks were artificially induced in controlled areas of the specimens by straining the substrates in tension. We designed and built a system to scan the specimen's surface at approximately 50 μm (0.002 in.) clearance with a sharp-pointed metal-tipped probe at high dc potential. The system measures the arc currents occurring at flaws, or plots a map of the scanned area showing points where the arc current exceeds a preset threshold. A theoretical model of the probe-specimen circuit shows constant dc potential to be the best choice for arc-discharge inspection of insulating coatings. Experimental observations and analysis of the data disclosed some potential for flaw description.

37725 **High temperature deformation of polycrystalline NiO and CoO.** Krishnamachari, V.; Notis, M.R. (Lehigh Univ., Bethlehem, PA). *Acta Metall.;* **25**: No. 11, 1307-1313(Nov 1977).

High temperature creep of polycrystalline NiO appears to be controlled by oxygen lattice diffusion at temperatures between 1273 and 1373 K and at stress levels from 34.5 to 79.8 MPa (5 to 11 ksi). Experimentally observed creep rates agree well with predictions obtained from deformation maps based on self-diffusion data. TEM examination indicates that dislocations present in crept NiO specimens are predominantly glide-type rather than climb-type dislocations as found in CoO. The difference in creep behavior of these materials is believed to be due to the difference in stacking fault energies and the nature of charge associated with lattice defects. 2 tables. 7 figs., 34 references.

37726 **Comments on "crack heating in UO_2".** Dutton, R. *J. Am. Ceram. Soc.;* **59**: No. 1-2, 88(1976).

The equation should read: -delta c/delta t = [(D/sub gb/ delta Z)/(4/L)][1 - exp (μ/sub n//RT)]. The rate of recovery strength d sigma/dt now becomes approximately equal to 5×10^{-4} dynes cm^{-2} s^{-1}, reduces the discrepancy but does not alter the conclusions of the paper.

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 36919, 37033, 37035, 37662, 37673, 37678, 37679, 37719

37727 (Y—2110) **Cementitious yttria products.** Holcombe, C.E. (Oak Ridge Y-12 Plant, Tenn. (USA)). Mar 1978. Contract W-7405-ENG-26. 23p. Dep. NTIS, PC A02/MF A01.

An investigation has been made of the physical properties and formation conditions of cements formed in the yttria/salt/water system. Cementitious binders were of the nominal $Y_2(OH)_5X.H_2O$ type (where X represents the Cl^- or NO_3^-). An ammonium nitrate-produced yttria cement was shown to be sinterable and was demonstrated to form very refractory castable concretes with zirconia or alumina aggregates.

37728 **Increase of the Curie temperature of the magnetic semiconductor EuO.** Borukhovich, A.S.; Bamburov, V.G.; Marunya, M.S.; Ignat'eva, N.I.; Iutin, N.N.; Finkel'shtein, L.D.; Galaktionov, V.D.; Gel'd, P.V. (Chemistry Institute, Urals Scientific Center, USSR Academy of Sciences). *Sov. Phys. - JETP (Engl. Transl.);* **45**: No. 4, 755-760(Apr 1977).

The possibilities are considered of greatly increasing the Curie temperature of ferromagnetic solid solutions based on europium monoxide while preserving the semiconducting character of their conductivity. The experimental results of this study attest to the existence of magnetic heterogeneity in homogeneous EuO-SmO solid solutions. The discussion is carried out within the framework of the magnetic impurity state and direct excited exchange models. It is suggested that the exchange interactions are switched in the investigated solid solutions in "relay" fashion.

37729 **Investigation of water desorption from the surface of the samples of aluminum during its levitation heating.** Kunin, L.L.; Rostotskaya, N.M.; Platonov, V.M. pp 2p, Paper 1F7 of Hydrogen in metals. Volume 7. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P7.

The influence of the oxide film structure and the development degree of the corroded surface of aluminum samples upon the quantity of adsorbed water was investigated by the proposed method.

37730 **Anharmonicity and superconductivity in metal hydrides.** Ganguly, B.N. (Xerox Corp., Webster, NY). pp 7p, Paper 1D11 of Hydrogen in metals. Volume 7. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P7.

The mechanisms of enhanced superconductivity and opposite isotope effect in metal hydride systems are discussed. Manifestations of the metallurgical properties of palladium—noble metal hydride systems in superconductivity are emphasized. A microscopic theory of superconductivity in anharmonic metal hydride system is formulated. 3 figures.

37731 **Surface impedance of palladium hydrides in the superconducting state.** Alquie, G.; Rivierre, B.; Kreisler, A.; Burger, J.P. (Universite Paris VI et Paris XI, France). pp 6p, Paper 2C12 of Hydrogen in metals. Volume 6. Elmsford, NY; Pergamon Press Inc. (1977). (In French)

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P6.

Preliminary surface impedance measurements of Pd-H/sub x/ compounds permits determination of the critical fields. A simple model of the variation of T/sub c/ and H/sub c/ with x is also proposed. 4 figures.

37732 **Estimation of Gibbs free energy functions.** Lindemer, T.B. (Oak Ridge National Lab., TN). *J. Am. Ceram. Soc.;* **59**: No. 1-2, 75-78(1976).

A computational method has been derived for the estimation of the molar heat capacity contribution to the Gibbs free energy function (fef/sub T/^{0}) above 298°K. This method, which is based on the observed temperature invariance of certain ratios of the integrals of these molar heat capacity contributions, has been applied to the analysis of fef/sub T/^{0} data for metal carbides, nitrides, fluorides, borides, and silicides in the crystalline state. The estimated fef/sub T/^{0} for a given compound is more accurate than that obtained by other known estimation techniques and permits a more accurate calculation of ΔG/sub T/^{0} than is possible from the commonly used approximation $\Delta G/\text{sub } T/^0 = \Delta G_{298}{}^0 - T\Delta S_{298}{}^0$. 3 tables.

37733 **Porosity dependence of elastic properties of polycrystalline cubic Lu_2O_3.** Hunter, O. Jr.; Graddy, G.E. Jr. (Ames Lab., IA). *J. Am. Ceram. Soc.;* **59**: No. 1-2, 82(1976).

The Young's modulus E and shear modulus G follow the equations E = 1927.3(1 - 2.267P) and G = 756.7(1 - 2.229P), where P = volume fraction porosity. These equations give extrapolated values for theoretically dense Lu_2O_3 of E_0 = 1927.3 kbars and G_0 = 756.7 kbars. The following relation between Poisson ratio μ and P is calculated: μ = (0.273 - 0.658P)/(1 - 2.229P), which results in an extrapolated value for μ at theoretical density of 0.273. The Debye temperature theta was calculated to be 460°K.

CORROSION AND EROSION

REFER ALSO TO CITATION(S) 36857, 37887

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 36918, 37709

37734 (KFK—2467) **Investigations on swelling and fission gas behaviour in oxide fuel under neutron irradiation.** Zimmermann, H. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Material- und Festkoerperforschung; Karlsruhe Univ. (TH) (Germany, F.R.). Fakultaet fuer Maschinenbau). Jun 1977. 102p. (In German). Dep. NTIS (US Sales Only), PC A06/MF A01.

Thesis.

Uranium dioxide irradiated under nearly isothermal conditions and U-Pu mixed oxide irradiated in fuel pins with high temperature gradients were investigated with respect to fission gas behaviour and fuel swelling. The irradiations of the UO_2 were carried out in two types of capsules, without any restraint in the first type and with strong radial restraint and axial loading in the other. The swelling was evaluated by measuring the volume changes of the fuel and by immersion density measurements before and after irradiation.

COMPOSITE MATERIALS

37735 (BNL—23496) **Applications of concrete polymer materials for the rehabilitation of bridge decks.** Kukacka, L.E. (Brookhaven National Lab., Upton, N.Y. (USA)). Oct 1977. Contract EY-76-C-02-0016. 8p. (CONF-780102—2). Dep. NTIS, PC A02/MF A01.

From Symposium on pioymers in concrete; Phoenix, AZ, USA (13 Jan 1978).

The rapid deterioration of concrete bridge decks as a result of the increased use of deicing salts is one of the most severe problems facing the highway industry today. One possible solution to the problem is the use of concrete polymer materials. The materials of prime interest are polymer-impregnated concrete (PIC) and polymer concrete (PC), both of which have excellent durability and strength properties. Three potential applications: repair of deteriorated bridge decks, polymer impregnation of new bridge deck surfaces, and full impregnation of precast deck panels have been studied in laboratory and field tests and the results have been encouraging. These results and economic considerations are described.

STRUCTURE AND PHASE STUDIES

37736 Effect of curing conditions on the capillary porosity of hardened portland cement pastes. Auskern, A.B.; Horn, W.H. (Brookhaven National Lab., Upton, NY). *J. Am. Ceram. Soc.;* **59**: No. 1-2, 29-33(1976).

The capillary pore structure of hardened portland cement pastes cured by high-pressure steam, chemical acceleration, high-pressure steam with reactive SiO_2, water immersion, water immersion and high-pressure steam, and hot-pressing was measured using mercury porosimetry to 50,000 psi. Differences of >2 orders of magnitude exist in the average capillary pore diameters of the cement pastes studied. The largest pores (approximately equal to 1 to 3 μm in diameter) are associated with high-pressure steam-cured pastes. The smallest average capillaries observed were 0.02 μm for pastes steam-cured with reactive SiO_2. Hot-pressed pastes had essentially no porosity accessible to mercury. The application of pore size control to problems of polymer-impregnated concrete is discussed. 3 tables, 6 figures.

MECHANICAL PROPERTIES

37737 (ORNL/TM—6086) **Bond between concrete and steel reinforcement at temperatures to 149°C (300°F).** Oland, C.B.; Callahan, J.P. (Oak Ridge National Lab., Tenn. (USA)). Apr 1978. Contract W-7405-ENG-26. 26p. Dep. NTIS, PC A03/MF A01.

Oak Ridge National Laboratory conducted a series of bond pull-out tests to determine the effect of elevated temperatures [ranging from 24 to 149°C (75 to 300°F)] on the bond strength between concrete and deformed steel reinforcement. This report summarizes the findings of the study, describes the tests and results, and offers recommendations for incorporating these results into the design of structures that must operate within the prescribed range of elevated temperatures.

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 37141

POLYMERS AND PLASTICS

STRUCTURE AND PHASE STUDIES

37738 (SAND—77-0822) **Development of a structure-property correlation for castable urethane elastomers.** Lagasse, R.R. (Sandia Labs., Albuquerque, N.Mex. (USA)). Jan 1978. Contract EY-76-C-04-0789. 50p. Dep. NTIS, PC A03/MF A01.

A significant problem in electronic encapsulation is the poor load bearing performance of existing replacements for Adiprene-MOCA urethane elastomer. In response to this problem, this study defines the structural features that control the viscoelastic properties of the following liquid castable elastomers: Adiprene-MOCA, EN-7, and 3121-S. A review of previous investigations on a related class of materials suggests that viscoelastic properties may be more directly related to the physical structure or morphology of these elastomers, rather than their chemical structure. Accordingly, the morphology of the subject elastomers is characterized by means of electron microscopy and x-ray scattering measurements. These measurements reveal that within each elastomer incompatible chain segments cluster into separate domains, or microphases on a scale of 10 +- 1 nm. On this basis, it is concluded that the two major thermomechanical transitions present in each elastomer can be assigned to separate transitions within the two microphases. The above-ambient transition, which determines the upper use temperature of the elastomer, is specifically assigned to the glass transition of an amorphous microphase. The significance of this structure-property correltion for the liquid castable elastomers is twofold: [1] it permits generalization of mechanical property measurements on existing materials in order to predict their performance in unusual applications and (2) it leads to a rational strategy for developing improved elastomers for new, more demanding applications.

PHYSICAL PROPERTIES

37739 (SAND—77-1735C) **Saturation remnant polarization of polyvinylidene fluoride.** Kepler, R.G. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1978. Contract EY-76-C-04-0789. 3p. (CONF-780305—3). Dep. NTIS, PC A02/MF A01.

From Division of fuel chemistry meeting; Anaheim, CA, USA (12 Mar 1978).

Measurements of saturation remnant polarization and of hysterisis loops which support the hypothesis that polyvinylidene fluoride is ferroelectric are reported. Measurements of the saturation remnant polarization have been reported previously, but the results disagree. An average value of 5.65×10^{-2} C/m^2 was obtained. 1 figure. (RWR)

DEGRADATION AND EROSION

REFER ALSO TO CITATION(S) 37072, 37788

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 37072, 37806, 37807

OTHER MATERIALS

PREPARATION AND MANUFACTURE

REFER ALSO TO CITATION(S) 37060, 37061, 37061, 37062, 37064, 37065, 37066, 37067, 37068, 37071

37740 (Juel—1417) **Pyrocarbon deposition from the gas-phase. A kinetic model.** Linke, J.; Koizlik, K.; Nickel, H. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorwerkstoffe und Heisse Zellen; Technische Hochschule Aachen (Germany, F.R.)). May 1977. 93p. (In German). Dep. NTIS (US Sales Only), PC A06/MF A01.

Thesis.

The pyrolysis of gaseous hydrocarbons is discussed on the basis of the so-called 'droplet-' or 'agglomerate-model'. This quantitative mechanism describes the formation of pyrocarbon by the four following steps: l) The process is initiated by mutual dissociation and polymerization of the gaseous hydrocarbon. 2) The formation of nuclei is favored by enrichment of the gas phase with carbonaceous species. 3) These nuclei can grow by the capture of other molecules or species, thus forming agglomerates. 4) The actual process of deposition consists in the accumulation of agglomerates to the substrate-surface. As a consequence of this model the physical properties of the resulting pyrocarbon layers are mainly influenced by the morphology of the agglomerates. This result corresponds very well to experimental data.

37741 High conductivity ZnSe films. Aranovich, J.; Fahrenbruch, A.L.; Bube, R.H. (Department of Materials Science and Engineering, Stanford University, Stanford, California 94305). *J. Appl. Phys.;* **49**: No. 4, 2584-2585(Apr 1978).

Thin films of ZnSe deposited by vacuum evaporation have a high resistivity ($>5 \times 10^8$ Ω cm), even when donor impurities such as Ga or In and additional Zn are coevaporated. High-conductivity films of ZnSe were produced by annealing films, deposited with coevaporated Ga and Zn, in Zn vapor at 500 °C. Film resistivities in the range 0.5-40 Ω cm were obtained in this way, corresponding to degenerate n-type material with electron densities in the 10^{19}-cm^{-3} range. Heterojunctions of n-ZnSe/p-CdTe and n-ZnSe/p-GaAs were investigated.

37742 Investigation of the design variables for producing activated carbons from Victorian brown coals by reaction with steam. McCarthy, D.J. *Carbon;* **15**: 95-101(1977).

The degree of coal gasification achieved, the ratio of steam feed rate to coal feed rate, and the temperature of activation for producing activated carbon were studied for Latrobe Valley brown coal reacted with steam in a continuous indirectly heated shaft activator. The degree of gasification is the most important variable. Process limitations which can be caused by channelling of both gas and solids and by heat transfer limitations are discussed briefly.

STRUCTURE AND PHASE STUDIES

37743 (IS-T—808) **Nuclear magnetic resonance study of metallic scandium chlorides.** McMullen, T.P. (Ames Lab., Iowa (USA)). Apr 1978. Contract W-7405-ENG-82. 76p. Dep. NTIS, PC A05/MF A01.

Thesis.

The ^{45}Sc nuclear magnetic resonance was studied in samples having the general composition CsSc/sub x/Cl_3 (0.67 less than or equal to x less than or equal to 1.0) in the CsCl-$ScCl_3$-Sc system. In particular the structure of $CsScCl_3$ suggests that it may be a one-dimensional conductor, and an attempt was therefore made to detect the occurrence of a metal-insulator transition of the type characteristic of one-dimensional conductors. Conventional crossed-coil (nuclear induction) techniques were employed. The ^{45}Sc resonance was studied over a wide frequency range (4 to 24 MHz) at 300K, these measurements yielding the Knight shift and nuclear electric quadrupole coupling parameters. No significant variation in the spectra occurred from 4.2K to 450K, indicating the absence of a metal-insulator transition in this temperature range.

37744 (Juel—1309) **Study of the structure of pyrocarbon coatings of fuel particles by transmission electron microscopy.** Pollmann, E.; Schuster, H.; Nickel, H. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorwerkstoffe und Heisse Zellen). Jul 1977. 61p. (In German). Dep. NTIS (US Sales Only), PC A05/MF A01.

Pyrocarbon is used as a coating material for fuel particles used in the High Temperature Reactor, and is deposited onto the fuel using a fluidized-bed technique. As a part of a basic research programme the microstructure of this pyrocarbon has been investigated by transmission electron microscopy. The deposition temperature and the concentration of the deposition gas in the fluidized bed were varied between 1,100 and 2,000°C and 5 and 60 v/o C_3H_8 respectively. It is shown that three different types of structure are obtained in the pyrocarbon. The development of these microstructures is dependent on the deposition temperature and the concentration of the deposition gas. The properties of the microstructures, as deduced by transmission electron microscopy, are in agreement with the results of other material characterization techniques.

37745 Comment on the tricritical point in SbSI. Samara, G.A. (Sandia Laboratories, Albuquerque, New Mexico 87115). *Phys. Rev., B;* **17**: No. 7, 3020-3022(1 Apr 1978).

Measurements of the pressure and temperature dependences of the c-axis static dielectric constant of SbSI in the vicinity of the ferroelectric transition have confirmed the existence of a tricritical point in this crystal at ~ 1.4 kbar and ~ 235 K.

37746 Magnetic susceptibility of oxygen adsorbed on graphite. Gregory, S. (Laboratory of Atomic and Solid State Physics, Cornell University, Ithaca, New York 14853). *Phys. Rev. Lett.;* **40**: No. 11, 723-725(13 Mar 1978).

The susceptibility of oxygen adsorbed on graphite indicates that magnetic transitions are present even in films of submonolayer thickness. This results contrasts with previous work on amorphous oxygen films and strongly supports the supposition that antiferromagnetic order can only be present simultaneously with configurational order.

PROPERTIES

REFER ALSO TO CITATION(S) 36650, 37727, 37759, 37819

37747 (TRG-Report—2986(S)) **Characterisation of graphite powders tested for use in HTR fuel compact matrices.** Moore, D.A.; Bilsby, C.F.; Ferguson, I.F.; Walker, D.E.Y. (UKAEA Reactor Group, Risley). Aug 1977. 46p. Dep. NTIS (US Sales Only), PC A03/MF A01.

A range of needle, natural and other graphite powders has been characterised to aid the choice of a powder suitable for use in the fabrication of Mk 3 HTR fuel compact matrices. The following techniques were applied: chemical analyis, particle size analysis, specific surface area and density measurements, gas desorption analysis, X-ray diffraction analysis, neutron capture cross section measurements, optical microscopy, and scanning and transmission electron microscopy. The results are presented and their relative merits discussed. Although most of the techniques applied are able to show differences between the powders, they do not enable precise fabrication behaviour to be predicted. Surface area measurements and particle shape indicate the approximate levels of resin to be used, particle size and shape indicate, in general terms, the ease of overcoating, and the particle size distribution, particle shape, crystallite size and dry compaction characteristics give a rough guide to how well the powders will compact.

37748 (UCID—17753) **Characterization of silicone potting compounds. I. Dynamic mechanical properties of two types of crosslinked silicone rubbers using the pheometrics mechanical sopectrometer in the eccentric rotating disk geometry.** Hoffman, D.M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Feb 1978. Contract W-7405-ENG-48. 30p. Dep. NTIS, PC A03/MF A01.

The eccentric rotating disk (ERD) technique for measuring the shear moduli and dynamic viscosity of crosslinked silicone compounds is described. Loss and storage moduli (G″ and G′) of cured Sylgard 184 and 186 are compared with DC-93-119 and DC-93-120. Some of the Sylgard silicones were modified prior to curing by additives, different initiators, or accelerators to change their physical properties. Because the low moduli (10^6 dynes/cm^2 for G′ to 10^4 dynes/cm^2 for G″) and crosslinked nature of the materials make conventional viscosity measurements or viscoelastic measurements difficult, the ERD technique was used. Procedures for the Rheometrics Mechanical Spectrometer ERD geometry are outlined in detail. It is shown that G′, G″ and eta′ (the dynamic viscosity) for cured Sylgards are higher than DC-93 silicone polymers. Although additives or multifunctional crosslinking agents cannot be used to convert a material property such as the dynamic modulus of one silicone to another chemically different silicone, it is possible to characterize a given crosslinked silicone rubber by its dynamic mechanical properties. Thus the dynamic mechanical properties of chemically similar cured silicones produced at any future date should compare with this report.

37749 High-pressure studies of thermoluminescence of doped ZnS phosphors. Hook III, J.W.; Drickamer, H.G. (School of Chemical Sciences and Materials Research Laboratory, University of Illinois at Urbana-Champaign, Urbana, Illinois 61801). *J. Appl. Phys.;* **49**: No. 4, 2503-2507(Apr 1978).

Thermoluminescence measurements have been made as a function of pressure to 40 kbars on three ZnS phosphors, two doped with Cu^+ and Cl^-, and one doped with Ag^+ and Cl^-. The apparatus is briefly described. The major features of the thermoluminescent spectra were a low-temperature peak which shifted to lower temperature with increasing pressure and a high-temperature peak which shifted rapidly to higher temperature. The entire spectrum decreased in intensity, which is consistent with House's measurements of the steady-state intensity. Data from three different heating rates gave consistent values for the trap depth. The change in energy of the electron trap with pressure obtained from these thermoluminescence measurements was quantitatively consistent with House's calculations based on steady-state data.

RADIATION EFFECTS

37750 Dependence of the compaction of vitreous silica on the ionization dose. Primak, W. (Argonne National Laboratory, Argonne, Illinois 60439). *J. Appl. Phys.;* **49**: No. 4, 2572(Apr 1978).

Earlier data for the relationship of negative dilatation of vitreous silica to the ionization dose of 0.3 and 0.6-MeV electrons are clarified and corrected. Values are given for the maximum and the mean dilatations along the electron path in the material.

37751 Radiation defects in p-type silicon irradiated with 30 MeV protons. Grigor'eva, G.M.; Kolodin, L.G.; Kreinin, L.B.; Mukashev, B.N.; Nusupov, K.K. (Institute of High-Energy Physics, Academy of Sciences of the Kazakh SSR, Alma-Ata). *Sov. Phys. - Semicond. (Engl. Transl.);* **11**: No. 11, 1278-1280(Nov 1977).

An investigation was made of radiation defects in p-type silicon irradiated with 30 MeV protons. An analysis of the influence of annealing on the recombination and electrical properties of silicon made it possible to elucidate the processes of formation and changes in radiation defects and to establish the conditions under which disordered regions began to affect the electrical properties of silicon. The damage coefficient of p-n solar energy converters, defined in terms of the change in the minority-carrier diffusion length L/sub n/ , was the same for the converters prepared by thermal diffusion and ion implantation.

37752 Formation of radiation defects in gadolinium-doped silicon. Akhmetov, V.D.; Bolotov, V.V.; Vasil'ev, A.V.; Karpov, Y.A.; Shakhovtsov, V.I.; Shindich, V.L. (Institute of Semiconductor Physics, Siberian Branch, Academy of Sciences of the USSR, Novosibirsk). *Sov. Phys. - Semicond. (Engl. Transl.);* **11**: No. 11, 1320-1321(Nov 1977).

37753 Influence of radiation defects on impurity diffusion in silicon. Karmanov, V.T.; Khokhlov, A.F.; Pavlov, P.V.; Zorin, E.I. (Physicotechnical Research Institute at the N. I. Lobachevski State University, Gorki). *Sov. Phys. - Semicond. (Engl. Transl.);* **11**: No. 10, 1096-1097(Oct 1977).

The diffusion of boron, phosphorus, and antimony in silicon previously irradiated with inert-gas ions was investigated. The radiation doses ranged from 6 x 10^{12} to 6 x 10^{15} ions/cm^2. Impurity diffusion took place at temperatures 700-1200°C. All impurities showed accelerated diffusion when the diffusion depth was comparable with the thickness of the layer damaged by bombardment. The acceleration increased with the previous radiation dose. For diffusion depths exceeding the thickness of the damaged layer, there was a retardation of diffusion due to segregation of impurities at sinks formed in the annealing process. The acceleration in the damaged layer was due to the presence of an excess concentration of vacancies released in the annealing of complex defects.

37754 Recombination in n-type silicon irradiated with high-energy gamma rays. Lugakov, P.F.; Tkachev, V.D.; Shusha, V.V. (Scientific-Research Institute of Applied Physics, Problems at the V. I. Lenin Belorussian State University, Minsk). *Sov. Phys. - Semicond. (Engl. Transl.);* **11**: No. 10, 1147-1148(Oct 1977).

An investigation was made of the recombination of nonequilibrium carriers in very pure zone-grown n-type silicon crystals (rho~2000 Ω.cm) irradiated with high-energy (E/sub m/ =100 MeV) gamma rays. Such irradiation produced clusters of intrinsic defects (or disordered regions) consisting of divacancies which gave rise to levels at which recombination took place.

CHEMISTRY

ANALYTICAL AND SEPARATIONS CHEMISTRY

REFER ALSO TO CITATION(S) 38068, 38072, 38333

37755 Determination of the chemical forms of trace metals in natural waters, with special reference to copper, lead, cadmium and zinc. Florence, T.M.; Batley, G.E. (Australian Atomic Energy Commission, Lucas Heights). *Talanta;* **24**: 151-158(1977).

Methods used to differentiate between the various chemical forms of a metal in a natural water are critically reviewed. The methods range from simple procedures which discriminate between weakly and strongly complexed forms of the metal, to comprehensive analytical schemes which can determine as many as seven species of each metal. The many problems involved in this exacting area of trace analysis are discussed in detail. 82 references.

ACTIVATION AND NUCLEAR REACTION PROCEDURES

REFER ALSO TO CITATION(S) 36842

37756 Comparison of three techniques for the measurement of depleted uranium in soils. Gladney, E.S.; Hensley, W.K.; Minor, M.M. (Los Alamos Scientific Lab., NM). *Anal. Chem.;* **50**: No. 4, 652-653(Apr 1978).

Instrumental Epithermal Neutron Activation Analysis has been shown to be an effective method for measuring depleted uranium in environmental samples. Good agreement was obtained with total U determinations by fluorometric technique, but poor correlation was observed with analyses done by delayed neutron assay technique. The ratio of U concentrations determined by delayed neutron assay and epithermal activation may be used to indicate isotopic deviation from natural abundance.

37757 Comparison of three techniques for rapid determination of strontium in soils and vegetation. Gladney, E.S.; Wangen, L.E.; Aguilar, R.D. (Los Alamos Scientific Lab., NM). *Anal. Lett.;* **10**: No. 13, 1083-1093(1977).

Instrumental epithermal neutron activation analysis, atomic absorption spectrophotometry, and instrumental thermal neutron activation analysis were compared to determine which technique produced best Sr data in the most expeditious fashion. Irradiation with epithermal neutrons was found to be the best method.

37758 Neutron activation analysis: an emerging technique for conservation/preservation. Sayre, E.V. (Brookhaven National Lab., Upton, NY). *Technol. Conserv.;* **1**: No. 3, vp(Win 1976).

The diverse applications of neutron activation in analysis, preservation, and documentation of art works and artifacts are described with illustrations for each application. The uses of this technique to solve problems of attribution and authentication, to reveal the inner structure and composition of art objects, and, in some instances to recreate details of the objects are described. A brief discussion of the theory and techniques of neutron activation analysis is also included.

CHEMICAL PROCEDURES

REFER ALSO TO CITATION(S) 36848, 37031, 37697, 38109, 38110, 38112

37759 (K/TL—729) **Evaluation of materials used in fire-resistant phenolic foam.** Daugherty, C.E.; Harris, G.E.; Wright, R.R. (Oak Ridge Gaseous Diffusion Plant, Tenn. (USA)). 1 Mar 1978. Contract W-7405-ENG-26. 14p. Dep. NTIS, PC A02/MF A01.

Materials to be used in the fire-resistant phenolic foam are outlined in the U.S. Atomic Energy Commission (Department of Energy) Material and Equipment Specification SP-9. Many of the specified materials are no longer available, or are difficult to obtain, due to specified vendor, grade, or mesh size. Compatibility evaluations of materials that are now being substituted for those outlined in the specification have been made, and the results are presented in this report. A number of tests were run on the substituted materials, including mesh evaluation, thermal gravimetric analyses, free-foam density, fire tests, and moisture tests. The tests indicated that the substituted materials did not affect the quality of the final foam product. It is recommended that the required properties of the final foam product be detailed in the material specification, along with suggested component materials that are known to yield an acceptable foam. Speification of component materials to be used should be avoided because material availability, material variations between vendors or between lots from the same vendor, and other differences would necessitate obtaining formal deviations from the specification or issuing frequent specification revisions.

37760 About hydrogen in copper alloys. Hourquin, R. (Trefimetaux, Argenteuil, France). pp 5p, Paper 1F2 of Hydrogen in metals. Volume 7. Elmsford, NY; Pergamon Press Inc. (1977). (In French)

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P7.

The hydrogen content of several copper alloys, as cast, was measured by melting in graphite under nitrogen. Other measurements were made on adjacent specimens in the solid states after various preliminary treatments, also in nitrogen. The results are then interpreted in terms of mobile and combined hydrogen (H_2O, in principal). 3 figures, 1 table.

37761 Rapid quantitative determination of the hydrogen content of aluminum alloys. McNamara, P. (Reynolds Metals Co., Richmond). pp 7p, Paper 1F10 of Hydrogen in metals. Volume 7. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P7.

A commercial Nitrogen Carrier Fusion (NCF) Instrument was evaluated for the rapid quantitative determination of the hydrogen content of aluminum alloys. 1 figure, 3 tables.

37762 Automatic determination of hydrogen in metals, together methods of sampling. Critical comments on the contemporary state of these methods. Thomich, W. (Gebr. Boehler, Duesseldorf). pp 5p, Paper 1F11 of Hydrogen in metals. Volume 7. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P7.

The advantages and disadvantages of the existing sampling techniques and methods for the determination of hydrogen are discussed. The requirements which the chemical analyst must

demand of a hydrogen determinator are defined, and the LECO RH-2 hydrogen determinator is described.

SPECTRAL PROCEDURES

REFER ALSO TO CITATION(S) 37756, 37757, 37930

37763 (UCRL—80038) **Sub-part-per-trillion detection of organics in aqueous solution by laser induced molecular fluorescence.** Richardson, J.H.; George, S.M.; Ando, M.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Mar 1978. Contract W-7405-ENG-48. 17p. (CONF-780434—1). Dep. NTIS, PC A02/MF A01.

From 9. symposium on trace organic analysis; Gaithersburg, MD, USA (10 Apr 1978).

Pulsed laser irradiation has been demonstrated to be a superior excitation source for fluorescence analysis. Three different configurations have been compared experimentally, and the superior system used as the excitation source in the trace analysis of several organics in aqueous solutions. In favorable cases sub-part-per-trillion detection limits can be achieved.

37764 Chemical ionization mass spectrometry as a tool for the elimination of surface related phenomena in the spectra of unstable compounds. Smith, R.D.; Ryan, P.W. (Battelle Pacific Northwest Labs., Richland, WA). *Anal. Chem.;* **50**: No. 2, 371-373(Feb 1978).

The occurrence of surface related reactions in mass spectrometer ion sources has long been recognized. The products of gas—surface reactions, involving surface ionization on the filament and pyrolysis on hot surfaces, often contribute minor peaks to electron impact (EI) mass spectra, and complications can be severe in the analysis of reactive or thermally unstable compounds. The resulting mass spectra may lead to an assumption of the presence of impurities not actually in the sample, or even cause errors in the identification of unknown compounds and mixtures. The purpose of this correspondence is to present an example of such surface related phenomena and to point out how these problems may be avoided utilizing chemical ionization (CI) mass spectrometry. The compound used to illustrate this problem is the brominated derivative of polymeric, sulfur nitride, (SN)/sub x/. (SN)/sub x/ has been previously found to produce a noncyclic $(SN)_4$ species upon sublimation. The brominated derivative, of empirical formula $SNBr_{0.4}$, was expected to yield $(SN)_4$ plus an unknown brominated species upon sublimation; hence, identification of the bromine containing species was of particular interest. Results show that argon (in the absence of a large water impurity) offers a distinct advantage for the analysis of mixtures over more commonly used methane, isobutane, and ammonia as a CI reagent. The latter involve relatively low energy proton transfer processes; hence, molecular species such as Br_2 and S_8 are not ionized by isobutane and NH_3 CI. Charge transfer from argon ions (Ar^+ and Ar_2^+ are the major reagent ions in this work) is a much higher energy process and is capable of ionizing most molecules. (JRD)

37765 (ORNL-tr—4606) **Simultaneous determination of uranium and plutonium in solutions of irradiated fast breeder fuel by x-ray spectrometry.** Ertel, D.; Wettstein, W. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Heisse Chemie). 1978. Translation by S.D. Blalock, Jr. of KFK—1121, 24 Mar 1970. 28p. Dep. NTIS, PC A03/MF A01.

The x-ray spectrometric simultaneous determination of uranium and plutonium in aqueous and organic Purex process solutions of irradiated fast breeder fuels is accomplished by intensity measurement of the L/sub alpha/$_1$ lines; thorium serves as an internal standard. An effective 10 μl of the solution to be analyzed is applied to a prepared paper filter, and measured in this form. Even highly active product solutions (up to 1000 Ci/l) can be studied without interference and without shielding because of the small material requirement. The analytical process requires neither separating nor stripping operations. In the measurement range 1 to 200 mg U, Pu/ml, linear calibration curves are in effect. The sensitivity of the method is about 3×10^5 ipm/mg U, Pu (W-tube, 55 kV—50 mA). The standard deviation in the optimum measurement range is about +-1 percent. The measurement results are recorded on punched tape and evaluated by computer. Uranium and plutonium do not reciprocally interfere with one another within the measurement range. The fission product radiation of the measurement sample represents neither a radiation risk for the laboratory personnel nor does it influence the measurement. At concentration ratios $Sr/Pu > 0.01$, interferences are to be expected as the result of line overlapping; such ratios, however, are not present in the product streams of the Purex process.

37766 High resolution laser spectroscopy with minute samples. Greenlees, G.W.; Clark, D.L.; Kaufman, S.L.; Lewis, D.A.; Tonn, J.F.; Broadhurst, J.H. (Univ. of Minnesota, Minneapolis). *Opt. Commun.;* **23**: No. 2, 236-239(Nov 1977).

A technique is described which enables high resolution measurements to be made, using a c-w tunable dye laser, with atomic beam fluxes as low as 10 atoms/s, corresponding to a spatial density of about 0.2 atoms/cm^3. The burst of resonantly scattered light, occurring as each atom crosses the laser beam, is recorded. Detected bursts of 3 photoelectron pulses, or more, show significant improvements in peak to background ratios. Results for Na (5890 A) and Ba (5535 A) are discussed. In both cases, the experimental resolution is determined by the natural linewidths of the transitions.

37767 Investigation of the distribution of the hydrogen on the structural components and on the macrodefects of solid states by using the laser-mass spectrometry. Zouev, B.K.; Koulakov, Y.A.; Kounin, L.L.; Mikhailova, G.V. pp 2p, Paper 1F4 of Hydrogen in metals. Volume 7. Elmsford, NY; Pergamon Press Inc. (1977). (In French)

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P7.

The distribution of hydrogen in chromium-covered steel was investigated. The hydrogen content in microcavities in the region of sulfate inclusions is estimated, and a separate determination of the superficial and volumetric hydrogen content in films was carried out.

37768 Solution-deposited standards using a capillary matrix and lyophilization. Baum, R.M. (Duke Univ., Durham, NC); Willis, R.D.; Walter, R.L.; Gutknecht, W.F.; Stiles, A.R. pp 165-173 of X-ray fluorescence analysis of environmental samples. Dzubay, T.G. (ed.). Ann Arbor, MI; Ann Arbor Science Publishers Inc. (1977).

Standards for calibration of x-ray fluorescence spectrometers are discussed. A technique is outlined that has distinct promise for the preparation of membrane filter standards for x-ray analysis. The work thus far has shown that these standards are relatively uniform and are highly reproducible from standard to standard. The technique is intrinsically simple, and precise replicates can be made rapidly. Also the solution-deposited standards are expected to be durable over a long time. It is felt that the technique is capable of a high degree of accuracy and is a very useful addition to the available techniques for preparation of standards. (JRD)

37769 TRACE: a least squares fitting program for PIXE spectra. Willis, R.D. (Duke Univ., Durham, NC); Baskin, A.B.; Walter, R.L. pp 259-267 of X-ray fluorescence analysis of environmental samples. Dzubay, T.G. (ed.). Ann Arbor, MI; Ann Arbor Science Publishers Inc. (1977).

The peak fitting program TRACE is described. The program is for off-line analysis in conjunction with a particle-induced x-ray emission (PIXE) analysis system. The code TRACE is capable of calculating fits to 16 to 20 elements in approximately one minute. An additional amount of time, approximately one minute, is currently required in the manual selection of data points used to generate the background shapes in the different fitting regions. For routine analysis this step in the fitting process can be handled by the computer in a negligible amount of time. (JRD)

37770 Sample preparation for emission spectrographic determination of impurities in elemental boron. Inlow, R.O. (Energy Research and Development Administration, Argonne, IL). *Anal. Lett.;* **10**: No. 13, 1075-1081(1977).

Accurate spectrographic determination of impurities in high-purity elemental boron requires that impurity elements be concentrated and collected in a suitable matrix while boron is separated from the sample. A method of acid dissolution followed by boron volatilization through an acetic anhydride and methanol treatment has been developed. This procedure is considerably faster and leaves lower residual boron concentrations than other methods. The mild conditions used to volatilize boron avoid the loss of any impurity elements from the sample.

SEPARATION PROCEDURES

REFER ALSO TO CITATION(S) 36908, 38193, 38194, 38261, 38268

37771 (CONF-770440—, pp 584-595) **Dump leaching: theory, experiment, and practice.** Cathles, L.M. (Kennecott Copper Corp., Lexington, MA); Reese, D.A.; Murr, L.E. 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

In past years a model of the leaching of copper from industrial waste dumps was developed that included air convection, mixed oxidation kinetics, and bacterial catalysis. This model was calibrated against the known leach histories of five test dumps built and operated by Kennecott. The calibrated model was then used to design a large scale leaching experiment in a thermally insulated stainless steel tank 40 ft high and 10 ft in diameter at the New Mexico Institute of Mining and Technology in Socorro, New Mexico. The column has been operated as scheduled for one year.

This paper analyzes the results of this test in such a way as to critically assess the adequacy of the model. Although there were some unexpected results and some changes in model parameters were required to explain the leaching of the column, the general validity of the model is confirmed by the large tank test.

37772 (CONF-770440—, pp 596-607) **Ammoniacal leaching of copper from chrysocolla in a dolomitic host rock: a laboratory study.** Moran, E.F. (E. I. du Pont de Nemours and Co., Inc., Wilmington, DE). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

The results of a laboratory program aimed at determining the feasibility of in situ leaching a highly dolomitic copper oxide orebody with an ammoniacal system is presented. Statistical analysis of extraction data showed that maximum extraction was obtained with 90 to 120 g/l NH_3 at pH approximately 9. The maximum copper extracted from fine particle size ore in 7 days was 60%. Tests to determine the reason for limited extraction indicated that blocking of the mineral surface occurred. Magnesium in solution was shown to have a striking effect on the copper extraction suggesting that it either precipitates on the ore surface or takes up a position in the silicate lattice vacated by the copper on initial leaching. Column leach tests were also carried out with larger size ore pieces to determine the effect of size. Leach rates were less than half that obtained in typical H_2SO_4 leaching of comparably copper mineralized non-limey ore. Based on the laboratory results ammoniacal leaching of the ore was not feasible.

37773 (CONF-770440—, pp 608-618) **Column leaching studies on copper oxide ore for in-situ application.** Shafer, J.L. (Occidental Research Corp., La Verne, CA); White, M.L.; Caenepeel, C.L. 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

In order to better evaluate the potential of copper oxide deposits for in-situ or heap leaching, it is necessry to be able to predict the rate of copper extraction and acid consumption. The modeling of copper oxide leaching, taking into account the vertical acid gradient, has not been previusly studied as extensively as sulfide dump leaching. Therefore, laboratory column leach studies where the pH gradient was monitored, were undertaken to verify the usefulness of several mathematical models. Attempts have been made to adapt the model proposed by Wadsworth et al. on the dump leaching of sulfide ore. In addition, Roman's oxide model has been investigated and modifications have been incorporated. Although preliminary column leach studies were made with minus one inch ore, later studies used 2400 lbs of minus three inch ore loaded into three eight-foot vertical columns, 15 in. in diameter, connected in series. The resulting copper sulfate solution was de-copperized on scrap iron and re-acidified for recycle back to the ore, similar to commercial practice.

37774 (CONF-770440—, pp 619-630) **Application of a mixed kinetics leaching model to an ore containing an assemblage of different copper minerals.** Madsen, B.W. (Bureau of Mines, Salt Lake City); Wadsworth, M.E. 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

The Federal Bureau of Mines has developed a mathematical model describing acidic ferric sulfate leaching of copper from sulfide ores to aid in improving dump leaching operations. The model is based on a steady-state approximation of the continuity equation for diffusion of ferric ions in the rock pores and the intrinsic leaching kinetics of the various sulfide mineral particles. Ore characteristics included in the model were particle size, particle shape, grade, mineral content, and mineral particle size. The continuity equation was used with ferric ion activity gradients and a fixed value for the diffusion coefficient. Except for diffusivity, each of these factors was either measured experimentally or estimated from theoretical considerations. The effective diffusivities were determined by fitting calculated leaching curves with experimental leaching data. The model accurately predicted copper extraction from an 8-ton sample during nearly 500 days of leaching.

37775 (CONF-770440—, pp 631-643) **Copper leaching from an orebody blasted in place.** Catanach, C.B.; Moran, E.F.; Porter, D.D.; Rudershausen, C.G.; Sommers, R.W. (E. I. du Pont de Nemours and Co., Inc., Wilmington, DE). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

A four million ton orebody of copper oxides and sulfides was fractured in place by a single carefully designed blast with conventional explosives that was the largest as of that date. In slightly less than two years, 15% of the copper was extracted. During shutdown, an additional 2% was recovered. Supported by further laboratory data, a mathematical model was developed that closely relates this data with actual leaching of the Old Reliable mine.

37776 (CONF-770440—, pp 644-652) **Economic considerations for recovering copper from deep sulfide deposits by nuclear rubblization.** Hard, R.A.; Klumpar, I.V.; Petrovic, L.J. (Kennecott Copper Corp., Lexington, MA). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

Copper recovery using nuclear rubblization and in situ leaching has been studied to estimate the economic feasibility and to identify problem areas for future research and development. A plan for commercializing this chemical mining process was built around a detonation schedule of 10 chimneys every 3 years, a leaching cycle of six years, and an annual copper production of 40,000 tons (metric). The results show that recovery using this method is profitable for a type of deposit that would be unprofitable by any conventional method. The release of radioactivity from the chimney during reentry and leaching operations, and the contamination of ground water and copper product were studied. A careful estimate of expected radiological exposures to plant workers and to the public indicates that all exposures will be below established guidelines.

37777 (CONF-770440—, pp 764-776) **Chemical, biological, and metallurgical aspects of large-scale column leaching experiments for solution mining and in-situ leaching.** Murr, L.E. (New Mexico Inst. of Mining and Tech., Socorro); Cathles, L.M.; Reese, D.A.; Hiskey, J.B.; Popp, C.J.; Brierley, J.A.; Bloss, D.; Berry, V.K.; Schlitt, W.J.; Hsu, P.C. 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

It is well known that the variations in temperature, chemical reactivity, and reaction rates which are presumed to occur and which in some cases have been shown to occur in a leach dump or similar solution mining activity are difficult to duplicate or model on a small laboratory scale, and the degree to which such large-size metallurgical processes can be scaled is not well established. In the present investigations the design criteria and sampling methods for large-scale leach tests on low-grade copper waste are outlined and the results of studies of temperature profiles and associated chemical and biological activity in 185 ton (1.63×10^5 kg) waste samples (approximately 10.75 m in height) are discussed. Various simple scaling features are presented, including drain-down characteristics and waste-body neutralization (of acid consuming minerals) for test samples of 7.0, 4×10^2, and 1.7×10^5 kg. Simple geometrical scaling laws are shown to closely describe the greater part of these processes. Temperature profiles in a large waste body are shown to be related to or correlated with bacterial activity, which is further shown to be related to available oxygen (and oxygen consumption). Aeration of large waste bodies is shown to be correlated with enhanced bacterial activity and leaching rates, and certain features of bacterial catalysis observed in the large-scale tests are corroborated by detailed laboratory studies of bacterial leaching phenomena utilizing the scanning electron microscope. Long-term data profiles showing a relationship between temperature, bacterial activity, oxygen consumption, and variations in Fe^{2+}, Fe^{3+}, Cu concentration, pH and Eh in the waste body are presented along with the variation of these parameters in the leach solution effluent as a function of solution flow rate.

37778 (CONF-770440—, pp 777-789) **Limitations of laboratory testing and evaluation of dump and in-situ leaching.** Roman, R.J. (New Mexico Bureau of Mines and Mineral Resources, Socorro). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

The models proposed for dump and in-situ leach are reviewed and areas of application discussed. The relevance of solution flow, dump compaction and rest cycles to the prediction of recovery versus time curve is explored. Areas in which past experience or field testing must be used to supplement laboratory test data to insure reliable predictions of field results are identified.

37779 **Binding of heavy metal ions by formaldehyde-polymerized peanut skins.** Randall, J.M.; Hautala, E.; McDonald, G. (Western Regional Research Lab., Berkeley, CA). *J. Appl. Polym. Sci.;* **22**: No. 2, 379-387(Feb 1978).

Peanut skin, when treated with formaldehyde to polymerize tannins, is a highly efficient substrate for removal of many heavy metal ions from aqueous waste solutions. The ions Ag^{1+}, Cd^{2+}, Cr^{6+}, Cu^{2+}, Hg^{2+}, Ni^{2+}, Pb^{2+}, Zn^{2+}, as well as Ca^{2+} and Mg^{2+}, were contacted with formaldehyde-treated peanut skin. Quantitative removal could be achieved with Ag^{1+}, Cd^{2+}, Cu^{2+}, Hg^{2+}, Pb^{2+}, and Zn^{2+}. Capacity of the substrate for ions was promising for Pb^{2+} (2.1

meq/g substrate), Cu^{2+} (3.0 meq/g), and Cd^{2+} (1.3 meq/g). Sorption from a solution containing Cd^{2+}, Cu^{2+}, Hg^{2+}, Ni^{2+}, Pb^{2+}, Zn^{2+} on a packed column of formaldehyde-treated peanut skin indicated that Hg^{2+}, Pb^{2+}, and Cu^{2+} were rapidly and completely bound to the packing, while Cd^{2+}, Ni^{2+}, and Zn^{2+} were poorly bound until the preferred ions had been removed from solution. 3 figures; 4 tables.

37780 Manometric investigation of the process of cupric sulfide bacterial leaching. Kulebakin, V.G. (Inst. of Soil Science and Agrochemistry, Novosibirsk, USSR). *Izv. Sib. Otd. Akad. Nauk SSSR, Ser. Biol. Nauk;* No. 15, 140-145(1977). (In Russian).

The process of bacterial leaching of the preliminary mechanically activated chalcocite and bornite has showed that O_2 consumption depends on the specific surface, method and size reduction time, and their physico—chemical peculiarities. Chemical activity of the chalcocite dry beating fraction has been found to be considerably higher than that of the wet grinding both in presence of Thiobacillus ferrooxidans and without them; the experiments with bornite have revealed contrary results. The direct bacterial influence is maximally revealed at bornite leaching irrespective of the size reduction method and specific surface.

37781 Mathematical models and calculation algorithms of extraction processes, complicated by chemical reactions. Rozen, A.M.; Zel'venskij, M.Ya.; Koltunov, V.S.; Marchenko, V.I. *Teor. Osn. Khim. Tekhnol.;* **10**: No. 5, 705-711(Sep 1976). (In Russian).

13 refs.; for English translation see the journal Theor. Found. Chem. Eng.

A general approach is considered to the construction of mathematical models of extraction processes in the apparatus with a stepwise phase contact, these processes being complicated by the chemical reactions proceeding in both aqueous and organic phases. A mathematical model is given of the processes of redox reextraction in the treatment of irradiated fuel elements with the use of ferric salts and tetravalent uranium as chemical reagents. The calculation algorithms for these processes are considered.

INORGANIC AND PHYSICAL CHEMISTRY

REFER ALSO TO CITATION(S) 36656

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

REFER ALSO TO CITATION(S) 36873, 37494, 37964

37782 (UCRL—52394) **Apparatus for simultaneously measuring electrical conductivity and oxygen fugacity.** Netherton, R.; Duba, A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 31 Jan 1978. Contract W-7405-ENG-48. 12p. Dep. NTIS, PC A02/MF A01.

Electrical conductivity studies of silicates are useful in determining temperature vs depth in the earth. Realistic laboratory measurements of conduction mechanisms require that exact determinations of oxygen fugacity (f_{O_2}) be made in the experimental environment. An apparatus is described that monitors system f_{O_2} with a calcia-doped zirconia-oxygen cell while measuring electrical conductivity of iron-bearing silicates at high temperature (greater than 1000 K). The f_{O_2} calculated thermodynamically from CO/CO_2 mixing ratios agreed well with measurements made with the zirconia cell at 1473 K, except for f_{O_2} greater than 10^{-4} Pa, where, on a $\log_{10}$ scale, mixing-ratio errors were as large as +- 0.2. These errors are attributed to oxygen contamination in the CO_2 and to mobile carbon deposits that formed in the apparatus.

37783 Thermal decomposition of ammonia—borane. Hu, M.G.; Geanangel, R.A.; Wendlandt, W.W. (Univ. of Houston, TX). *Thermochim. Acta;* **23**: No. 2, 249-255(Apr 1978).

The thermal decomposition of ammonia—borane has been studied by thermogravimetry, differential thermal analysis, and decomposition product measurements. Vigorous decomposition with hydrogen evolution begins near 120°C and proceeds in stages as the temperature is increased to 200°C leaving a white residue. The composition of the residue was approximately $BNH_{2\cdot1}$ after heating to 170°C and BNH/sub (0.8—1.2)/ after heating to 200°C. The ir spectrum gave evidence of further slow hydrogen loss above that temperature.

37784 (SAND—78-6009) **Vapor pressure of saturated solutions and hydrates of magnesium chloride.** Kondyrev, N.V.; Berezovskii, G.V. Translated by P. Newman from *Zh. Obshch. Khim.;* No. 5, 1246-1251(1935). 17p. Dep. NTIS, PC A02/MF A01.

Portions of document are illegible.

The static method described by Bolte and Bremer—Frowein was used to measure vapor pressure of the $MgCl_2$-H_2O system. The vapor pressures of the following systems were found: (1) saturated solutions of $MgCl_2.6H_2O$ in the temperature range 15 to 100°, (2) the systems $MgCl_2.6H_2O$—$MgCl_2.4H_2O$ in the temperature range 20 to 150°, and (3) crystals of $MgCl_2.4H_2O$ in the temperature range 10 to 160°. 5 tables.

ISOTOPE EFFECTS

REFER ALSO TO CITATION(S) 37634, 37687, 37719, 37730, 37808

ISOTOPE EXCHANGE AND ISOTOPE SEPARATION

REFER ALSO TO CITATION(S) 37020

37785 Method for the preparation of an element or a compound of an element that is enriched with an isotope of that element. (to Philips Gloeilampenfabrieken N.V., Eindhoven (Netherlands)). Netherlands Patent 760,2751/A/. 17 Mar 1976. 10p. (In Dutch).

A simple and inexpensive method for the preparation of isotope-enriched elements or compounds for isotope separation which also requires relatively low-energy use is discussed here. A characteristic of this process is that part of the original substance is converted in a reaction area on a heated substrate through deposition of the thereby formed element or compound on that substrate, whereby what remains of the original substance goes through this same process until sufficient enrichment has occurred.

ORGANIC CHEMISTRY

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

REFER ALSO TO CITATION(S) 36873, 37044

37786 On the high temperature chemical equilibria of polycyclic aromatic hydrocarbons. Stein, S.E. (West Virginia Univ., Morgantown). *J. Phys. Chem.;* **82**: No. 5, 566-571(9 Mar 1978).

Concentrations of selected benzenoid polycyclic aromatic hydrocarbons in equilibrium with acetylene and hydrogen over the range 1400-3000 K are estimated by extension and application of existing predictive methods. Implications of these results concerning chemical equilibria and reaction kinetics of high temperature hydrocarbon systems are explored. Of special interest is the finding that in idealized homogeneous equilibrium systems above 1700 K, there exists a "critical" highly condensed polycyclic aromatic species whose concentration is at a minimum relative to other highly condensed aromatics. Equilibrium concentration and size of this critical species depend on temperature and partial pressures of light gases (chiefly acetylene and hydrogen) and this species may constitute a natural thermodynamic barrier for homogeneous high temperature carbon particle formation. Also, concentrations of polyaromatic members of the most thermodynamically stable "benzene polymerization" pathway are examined in selective equilibrium with benzene and hydrogen. For this series, over a wide range of conditions, o-terphenyl is found to have the lowest equilibrium concentration. 2 tables, 6 figures.

37787 cis-4,4'-stilbenediols. Synthesis from dienestrol, structure, and photocyclization to dihydrophenanthrenes. Maienthal, M. (Food and Drug Administration, Washington, DC); Benson, W.R.; Sheninin, E.B.; Doyle, T.D.; Filipescu, N. *J. Org. Chem.;* **43**: No. 5, 972-975(3 Mar 1978).

Diels—Alder cycloaddition reactions between dienestrol or its diacetate and dienophiles maleic anhydride, 4-phenyl-1,2,4-triazoline-3,5-dione, dimethyl maleate, 1,4-naphthoquinone, and tetracyanoethylene yielded adducts representing 4,4'-stilbenediols with obligate cis configuration. These compounds are ideally suited for studying the photochemical conversion of stilbene-like molecules to dihydrophenanthrenes without interference from the trans-stilbene isomers. The structures and stereochemistry of the Diels—Alder adducts were established by detailed interpretation of their NMR and mass spectra. UV irradiation of the synthesized cis-stilbenes caused photocyclization to the respective 4a,4b-dihydrophenanthrenes without interfering side reactions and with quantum yields in excess of 0.85.

37788 Reclamation of vulcanized rubbers by chemical degradation. VIII. Absorption of oxygen and degradation of cis-1,4-polyisoprene by phenylhydrazine—iron(II) chloride system. Yamashita, S.; Kato, S.; Kawabata, N.; Okamoto, T. (Kyoto Inst. of Tech.). *J. Appl. Polym. Sci.;* **22**: No. 2, 353-360(Feb 1978).

Absorption of oxygen and degradation of cis-1,4-polyisoprene by the phenylhydrazine-iron(II) chloride system was investigated at 30°C in connection with the mechanism of reclamation of vulcanized rubbers by the system. In the presence of iron(II) chloride, phenylhydrazine rapidly absorbed an equimolar amount of oxygen and evolved an equimolar amount of nitrogen. Gas-chromatographic analysis of the reaction mixture showed the presence of benzene,

phenol, and biphenyl in 37%, 35-60%, and 4-8% yields, respectively, based on phenylhydrazine. When cis-1,4-polyisoprene was added to the reaction mixture, additional absorption of oxygen was observed. Molecular weight of the polymer decreased during the oxygen absorption, and the scission efficiency (i.e., number of mole scissions/mole oxygen) was 0.14-0.26. 2 tables; 3 figures.

37789 Amplification before decay of perturbations around stable states in a model of the Zhabotinskii reaction. Troy, W.C. (Univ. of Pittsburgh); Field, R.J. *SIAM J. Appl. Math.;* 32: No. 2, 306-322(Mar 1977).

The Field—Noyes model of the Belousov—Zhabotinskii reaction has attracted attention since it is apparently the only such model that is derived directly from detailed knowledge of a real oscillating chemical reaction. The values of most of the parameters in the model are easily assignable by analogy to the chemistry occurring in the real system. However, two parameters are only qualitatively related to this chemistry, and the behavior of the model as the values of these parameters are varied is of interest. Earlier numerical and qualitative work has shown that the model exhibits limit cycle oscillations for certain values of these parameters. The present qualitative work shows that for other values limit cycles do not appear, as the physically significant steady state is globally asymptotically stable. However, this steady state may be excitable in that a finite perturbation is greatly amplified before the system returns to rest. The size of the excursion depends upon the value of a parameter related to an autocatalytic portion of the model. The relationship between this excitability and phenomena actually observed in the reaction is discussed, and an analogy is drawn between the behavior of this model and of modifications of the Hodgkin—Huxley model for nerve impulse transmission.

37790 Visualization of drug-nucleic acid interactions at atomic resolution. I. Structure of an ethidium/dinucleoside monophosphate crystalline complex, ethidium:5-iodouridylyl(3′5′)adenosine. Tsai, C.C.; Jain, S.C.; Sobell, H.M. (Univ. of Rochester, NY). *J. Mol. Biol.;* 114: 301-315(1977).

Ethidium forms a crystalline complex with the dinucleoside monophosphate 5-iodouridylyl(3′-5′)adenosine (iodoUpA). These crystals are monoclinic, space group C2, with unit cell dimensions, a = 28.45 A, b = 13.54 A, c = 34.13 A, β = 98.6°. The structure has been solved to atomic resolution by Patterson and Fourier methods, and refined by full matrix least-squares to a residual of 0.20 on 2017 observed reflections. The asymmetric unit contains two ethidium molecules, two iodoUpA molecules and 27 water molecules, a total of 155 atoms excluding hydrogens. The two iodoUpA molecules are held together by adenine.uracil Watson—Crick-type base-pairing. Adjacent base-pairs within this paired iodoUpA structure and between neighboring iodoUpA molecules in adjoining unit cells are separated by about 6.7 A; this separation results from intercalative binding by one ethidium molecule and stacking by the other ethidium molecule above and below the base-pairs. Noncrystallographic 2-fold symmetry is utilized in this model drug—nucleic acid interaction, the intercalated ethidium molecule being oriented such that its phenyl and ethyl groups lie in the narrow groove of the miniature nucleic acid double-helix. Base-pairs within the paired nucleotide units are related by a twist of 8°. The magnitude of this angular twist is related to conformational changes in the sugar—phosphate chains that accompany drug intercalation. These changes partly reflect the differences in ribose sugar ring puckering that are observed. Additional small but systematic changes occur in torsional angles that involve the phosphodiester linkages and the C4′—C5′ bond. Solution studies have indicated a marked sequence-specific binding preference in ethidium—dinucleotide interactions, and a probable structural explanation for this is provided by this study.

37791 Visualization of drug-nucleic acid interactions at atomic resolution. III. Unifying structural concepts in understanding drug-DNA interactions and their broader implications in understanding protein-DNA interactions. Sobell, H.M.; Tsai, C.C.; Jain, S.C.; Gilbert, S.G. (Univ. of Rochester, NY). *J. Mol. Biol.;* 114: 333-365(1977).

Structural information afforded by the x-ray crystallographic studies of ethidium—dinucleoside monophosphate crystalline complexes described in the previous preceding two papers has led to a detailed model for ethidium—DNA binding. Features of ethidium--DNA binding, in turn, have led to unifying structural concepts in understanding a wide range of drug-DNA interactions. It is possible that these concepts have still broader implications in understanding the nature of protein—DNA interactions. A summary is presented of the stereochemical aspects of ethidium—DNA, actinomycin--DNA and irehdiamine—DNA binding, molecules that use intercalative and kinked-type geometries in binding to DNA. Descriptions are included of the superhelical DNA structures formed by kinking DNA periodically varying numbers of base-pairs apart; kappa-kinked B DNA, a structure formed by kinking DNA every ten base-pairs, is a left-handed superhelical structure that may be utilized in the organization of DNA within the nucleosome in chromatin while β-kinked B DNA is a right-handed superhelical structure formed by kinking DNA every two base-pairs. It is possible that premelting conformational changes occur in DNA which utilize elements of this structure. This exposes base-pairs to solvent denaturation, and could lower the activation energy necessary for strand separation during DNA denaturation. RNA polymerase and other DNA melting proteins could capitalize on this type of premelting conformational change when binding to DNA. The concept that conformational flexibility exists in DNA structure (and that drug intercalation is a phenomenon that reflects this flexibility) can, in addition, explain a wide variety of physicochemical data about DNA. The nature of these data is discussed in detail.

37792 Visualization of drug-nucleic acid interactions at atomic resolution. II. Structure of an ethidium/dinucleoside monophosphate crystalline complex, ethidium:5-iodocytidylyl(3′5′)guanosine. Jain, S.C.; Tsair, C.C.; Sobell, H.M. (Univ. of Rochester, NY). *J. Mol. Biol.;* 114: 317-331(1977).

Ethidium forms a second crystalline complex with the dinucleoside monophosphate 5-iodocytidyl(3′-5′)guanosine (iodoCpG). These crystals are monoclinic, $P2_1$, with a = 14.06 A, b = 32.34 A, c = 16.53 A, β = 117.8°. The structure has been solved to atomic resolution using rigid-body Patterson vector search and Fourier methods, and refined by full matrix least-squares to a residual of 0.16 on 3180 observed reflections. Both iodoCpG molecules are hydrogen-bonded together by guanine.cytosine Watson—Crick base-pairing. Adjacent base-pairs within this paired iodoCpG structure and between neighboring iodoCpG molecules in adjoining unit cells are separated by 6.7 A. Approximate 2-fold symmetry is used in the interaction; this reflects the pseudo-2-fold symmetry axis of the phenanthridinium ring system in ethidium coinciding with the approximate 2-fold axis relating base-paired iodoCpG molecules. The phenyl and ethyl groups of the intercalated ethidium molecule lie in the narrow groove of the miniature iodoCpG double-helix. The stacked ethidium, however, lies in the opposite direction, its phenyl and ethyl groups neighboring iodine atoms on cytosine residues. Base-pairs within the paired nucleotide units are related by a twist of about 8°. The magnitude of this angular twist reflects conformational changes in the sugar—phosphate chains accompanying intercalation. These primarily reflect the differences in ribose sugar ring puckering that are observed (i.e., both iodocytidine residues have C3′ endo sugar conformations, while both guanosine residues have C2′ endo sugar conformations), and alterations in the glycosidic torsional angles that describe the base-sugar orientation.

37793 Crystal and molecular structure of bicyclo[2.2.1]-hept-2-en-5,6-dinitrosocobalt-eta^5-cyclopentadienide. Evidence for a nitroxyl diradical bidentate ligand. Evrard, G.; Thomas, R.; Davis, B.R.; Bernal, I. (Brookhaven National Lab., Upton, NY). *J. Organomet. Chem.;* 124: 59-70(1977).

An accurate x-ray crystallographic structural study of a metal complex having a nitroxyl diradical as a bidentate ligand has been carried out. Bicyclo[2.2.1]-hept-2-en-5,6-dinitrosocobalt-eta^5-cyclopentadienide crystallizes in space group P anti 1 with Z 2, a 8.245 +- 0.007, b 10.285 +- 0.016, c 7.888 +- 0.008 A and α 59.276 +- 0.073, β 101.099 +- 0.053, γ 108.802 +- 0.067°. Intensities of 1831 independent reflections were used in the refinement of the structure to an R(F) of 4.6%. The bonding of the Co atom to the cyclopentadienyl ligand appears to be a normal pentahapto linkage. The lone double bond and the C—C single bonds adjacent to the endo hydrogens of the norbornene fragment of the molecule are shorter than have previously been reported for this moiety. This study represents the first structural report of NO groups bridging to Co. The Co—N—O angles (129.4(3) and 128.9(3)°) and the NO stretching frequency (1357 cm^{-1}) of the title compound resemble values found in nitroxyl free radical compounds more closely than values found in bridging NO group compounds.

37794 (ORNL-tr—4611) **Studies on carbamates. IV. The carbamates of hydrazine.** Staal, E.; Faurholt, C. Translated by S.D. Blalock Jr. from *Dan. Tidsskr. Farm.;* 25: 1-12(1951). 10p. Dep. NTIS, PC A02/MF A01.

The subject of this investigation is the equilibrium conditions and reaction mechanism of the formation and decomposition of carbamate formed from hydrazine and carbon dioxide in aqueous medium. The experiments are carried out at 18°C. The velocity constants are calculated by means of Briggs's logarithms, the unit of time being the minute. When carbon dioxide is led into a solution of hydrazine and sodium hydroxide, both carbamate and carbonate are formed, the carbon dioxide reacting with hydrazine to form carbamate, as well as with hydroxyl ions to form carbonate. From these experiments it is possible to calculate the velocity constant, k/sub CO_2.Am/ for the addition of carbon dioxide to hydrazine. k/sub CO_2.Am/ is found to be 10/sup 5.51/.

ELECTROCHEMISTRY

37795 Effect of electrode placement and finite matrix conductivity on the performance of flow-through porous electrodes. Trainham, J.A.; Newman, J. (Univ. of California, Berkeley). *J. Electrochem. Soc.;* **125**: No. 1, 58-68(Jan 1978).

A one-dimensional model for flow-through porous electrodes is used to predict the effluent concentration as a function of matrix conductivity and electrode length for upstream and downstream placement of the counterelectrode and current collector relative to the fluid inlet to the working electrode. Two chemical systems are considered: (1) the removal of copper from sulfate solutions, and (2) the removal of silver from thiosulfate solutions. For an infinite matrix conductivity, the lowest effluent concentration is achieved when the counterelectrode is placed upstream to the fluid inlet of the working electrode. When the matrix conductivity is small, the lowest effluent concentration is still achieved for upstream placement of the counterelectrode; however, the optimum placement of the current collector depends on the chemical system and the value of the matrix conductivity that can be achieved in practice. Calculations show that for downstream placement of the counterelectrode a limiting current distribution cannot be achieved (for electrode lengths of interest here). The most undesirable configuration for achieving a low effluent concentration when the matrix conductivity is low is when both the counterelectrode and current collector are placed downstream of the fluid inlet. Distribution of potential, reaction rate, and electric driving force are presented for four different configurations: (1) upstream counterelectrode, downstream current collector, (2) downstream counterelectrode, upstream current collector, (3) upstream counterelectrode, upstream current collector, and (4) downstream counterelectrode, downstream current collector.

37796 Ring electrodes. Pierini, P.; Newman, J. (Univ. of California, Berkeley). *J. Electrochem. Soc.;* **125**: No. 1, 79-84(Jan 1978).

The primary and secondary current distributions and the primary resistance for ring electrodes are presented. Current distributions, including mass transfer effects, for various potential dependent heterogeneous kietics are computed for a representative set of rotating-ring electrode geometries.

PHOTOCHEMISTRY

REFER ALSO TO CITATION(S) 37964, 37987, 37988

37797 Photomonomerization of pyrimidine dimers by indoles and proteins. Chen, J.; Huang, C.W.; Hinman, L.; Gordon, M.P.; Deranleau, D.A. (Univ. of Washington, Seattle). *J. Theor. Biol.;* **62**: 53-67(1976).

Model systems for the study of photoreactivation have been developed that utilize a variety of indole derivatives. These systems can split uracil cis-syn cyclobutadipyrimidine, either free or in RNA, when irradiated at wavelengths absorbed only by the indole moiety. The ability of indole compounds to split dimers is closely related to their electronic properties. Those of high electron-donor capacity such as indole, 3-methylindole, indole-3-acetic acid, 5-hydroxytryptophan and tryptophan are good photosensitizers, with efficacy in that order. Indoles with electron-withdrawing substituents such as indole-3-carboxylic acid, indole-3-aldehyde and oxindole are inactive in the monomerization reaction. These findings support the proposed mechanism that the photosensitized monomerization occurs as a result of electron transfer from the excited indole molecules to the pyrimidine bases. Proteins containing fully exposed tryptophan residues (chicken egg white lysozyme and bovine diisopropylphosphoryltrypsin) also cause the splitting of the ^{14}C-labeled dimers under the same conditions. In the case of lysozyme the quantum yield of monomerization is similar to that of free tryptophan. Much of the monomerization ability of lysozyme was lost after the solvent-available tryptophan had been oxidized by treatment with N-bromosuccinimide. Bovine pancreatic ribonuclease A, a protein devoid of tryptophan, failed to exhibit photosensitized monomerization of uracil dimers. The biological implication of these reactions involving a protein with an exposed tryptophan residue is discussed. Although indoles are able to split the dimers in RNA, they fail to photoreactivate uv-damaged TMV-RNA. Indole-3-acetic acid, 3-methylindole and 5-hydroxytryptophan rapidly inactive viral RNA when irradiated at 313 nm, possibly because of side reactions.

RADIATION CHEMISTRY

REFER ALSO TO CITATION(S) 37023

37798 Paramagnetic and optical studies of radiation damage centers in K(H/sub 1-x/D/sub x/)$_2$PO$_4$. McMillan, J.A.; Clemens, J.M. (Argonne National Laboratory, Argonne, Illinois 60439). *J. Chem. Phys.;* **68**: No. 8, 3627-3631(15 Apr 1978).

Optical and EPR studies of K(H/sub 1-x/D/sub x/)$_2$PO$_4$ ($0 < \text{or} = x < \text{or} = 1$) single crystals irradiated at 77°K with ^{60}Co gamma rays and observed in liquid nitrogen, argon, and oxygen, have permitted not only the identification of two radical species produced as HPO^-_4 and H_2PO_4, but also a description of the annealing processes and their correlation with the ferroelectric transition temperature. Magnetic and kinetic parameters are given.

37799 Effect of field-dependent mobility on the escape probability. I. Electrons photoinjected in neopentane. Mozumder, A.; Carmichael, I. (Radiation Laboratory, University of Notre Dame, Notre Dame, Indiana 46556). *J. Chem. Phys.;* **68**: No. 8, 3808-3813(15 Apr 1978).

A general procedure is described for calculating the escape probability of an electron against neutralization in the presence of an external field after it has been ejected into a dielectric liquid from a planar surface. The present paper utilizes the field-dependent electron mobility measurement in neopentane by Bakale and Schmidt. The calculated escape probability, upon averaging over the initial distribution, is compared with the current efficiency measurement of Holroyd et al. The median thermalization legnth, inferred from this comparison, depends in general upon the assumed form of initial distribution. It is less than the value obtained when the field dependence of the mobility is ignored but greater than that applicable to the high energy irradiation case. A plausible explanation is offered.

37800 Reactions of radicals with lecithin bilayers. Barber, D.J.W.; Thomas, J.K. (Univ. of Notre Dame, IN). *Radiat. Res.;* **74**: No. 1, 51-65(Apr 1978).

The kinetics of reaction of .OH and e/sub aq/$^-$ with lecithin bilayers have been measured. The rate for .OH + lecithin is 5.1 +- 0.9 x 10^8 M^{-1} sec^{-1} while the e/sub aq/$^-$ + lecithin rate is very slow. When a solute such as pyrene is solubilized in the bilayer, .OH and e/sub aq/$^-$ may react with the solute; rates of 1.65 +- 0.12 x 10^9 M^{-1} sec^{-1} and 7 x 10^7 M^{-1} sec^{-1} have been measured for reaction of .OH and e/sub aq/$^-$, respectively, with pyrene in lecithin. These rates are lower than those observed for similar reactions in homogeneous systems. This is explained in terms of (a) the protective effect of the bilayer, this being especially true for e/sub aq/$^-$ which does not readily leave the aqueous phase, and (b) in terms of the restricted diffusion imposed on the reactive species by the bilayer. The kinetics in these model systems are relevant to reactions of radicals with membranes. Long-term alteration in the model membrane following .OH attack is manifested in terms of damage to the head group, increasing water penetration of the bilayer, and of cross-linking with the membrane, thereby restricting motion in the interior of the bilayer. Increased rigidity and leakiness of membranes is an expected consequence of radiation damage.

37801 Quantum beats of recoil-free γ radiation. Perlow, G.J. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev. Lett.;* **40**: No. 13, 896-899(27 Mar 1978).

Recoil-free γ rays from the decay of ^{57}Co are frequency modulated by vibrating the source with a piezoelectric crystal and one of the lines of the resulting multiplet emission spectrum is absorbed. The remaining radiation displays a time-dependent counting rate whose harmonic composition and relative phases are sensitive to small energy shifts and can be used for their measurement.

37802 Irradiation of benzene with $^{14}CH^+$ and $^{14}CH_3^+$ ions. Erwin, W.R.; Gordon, B.E.; Spicer, L.D.; Lemmon, R.M. (Univ. of California, Berkeley). *J. Phys. Chem.;* **82**: No. 6, 654-656(23 Mar 1978).

Solid benzene at -196°C was irradiated with $^{14}CH^+$ and $^{14}CH_3^+$ ions in 10-eV kinetic energy. Yields were determined for the labeled hydrocarbon products: benzene, toluene, cycloheptatriene, diphenylmethane, biphenyl, and phenylcycloheptatriene. The radioactivity distributions between the ring and the methyl group of the toluene product were also determined. These results have been compared to those previously obtained with $^{14}C^+$ and $^{14}CH_2^+$ ions. The comparisons have provided both insight into the reaction mechanisms and a tentative estimate of the distribution of the species (^{14}CH/sub x/) that react with the benzene.

37803 Positron lifetime studies of γ-irradiated organic crystals. Jean, Y.C.; Ache, H.J. (Virginia Polytechnic Inst. and State Univ., Blacksburg). *J. Phys. Chem.;* **82**: No. 6, 656-659(23 Mar 1978).

Four organic solids, adamantane, guanosine, 2′-deoxyuridine, and 5-iodo-2′-deoxyuridine were γ irradiated in the dose range from 0 to 200 Mrad and their positron annihilation lifetimes and ESR signals measured, with and without subsequent thermal annealing. No consistent correlation between the positron lifetime data, lambda$_1$, lambda$_2$, and I_2 and free-radical concentration or absorbed radiation dose could be observed. On the basis of these results, it

appears that the positron annihilation method is not a direct technique for the study of paramagnetic centers or radicals in irradiated solid organic materials because the interactions of positron or positronium with these species are frequently obscured by the response of the positron annihilation process to radiation-induced structural changes in these solid materials.

37804 Phosphate radicals. Spectra, acid-base equilibria, and reactions with inorganic compounds. Maruthamuthu, P.; Neta, P. (Univ. of Notre Dame, IN). *J. Phys. Chem.;* **82**: No. 6, 710-713(23 Mar 1978).

The phosphate radicals were produced by the reaction of e/sub eq/$^-$ with peroxodiphosphate ions and their spectra and acid-base equilibria were determined. The reaction of OH with phosphate ions was also examined and discrepancies in the literature are discussed. The rate constants for the reactions of the acid-base forms of the phosphate radical, as well as those of the sulfate radical, with several inorganic compounds were determined. These reactions involve either hydrogen abstraction or one-electron oxidation. The radicals formed by H abstraction from H_2O_2, HOP_3^{2-}, and $H_2PO_2^-$ can reduce peroxodisulfate and peroxodiphosphate efficiently and thus propagate a chain reaction. The rate constants for the abstraction reactions are similar for SO_4^- and H_2PO_4 but slower for HPO_4^- and PO_4^{2-}. The rate constants for oxidation differ considerably for the different radicals and substrates. From these rates it is concluded that the oxidation capabilities decrease in the order SO_4^- greater than H_2PO_4 greater than HPO_4 greater than PO_4^{2-}.

37805 Fast reaction kinetics of one-electron transfer in proteins. The histidyl radical. Mode of electron migration. Faraggi, M.; Klapper, M.H.; Dorfman, L.M. (Ohio State Univ., Columbus). *J. Phys. Chem.;* **82**: No. 5, 508-512(9 Mar 1978).

The one-electron reduction of ribonuclease, lysozyme, α-chymotrypsin, trypsin, and α/sub s,1/-casein has been studied by pulse radiolysis. The optical absorption spectra and the decay kinetics of the transient products are pH dependent. In addition to the well-known band at 410 nm, obtained from proteins with disulfide bridges, which earlier workers have assigned to the disulfide radical anion ($RSSR^-$), a band at 360-nm appears under slightly acid conditions. From an examination of the solution conditions which lead to this 360-nm band, the properties of the band itself, and the observation that it is found with α/sub s,1/-casein (which contains no disulfide bridge), we conclude that the 360-nm band is associated with an electron-imidazole adduct in proteins. The yield of histidyl radical and the titration curves obtained with trypsin and with α-chymotrypsin are consistent with a pK/sub a/ < 4.5 for the active site histidines of these two proteins. On the basis of our observed yields of the transient bands in α-chymotrypsin, the individual rate constants for attachment of e/sub aq/$^-$ to the reactive groups, the number of each type of reactive group, and their accessibility in the protein structure as revealed by the x-ray crystallography studies of Birktoft and Blow, we suggest that the carbonyl groups are the predominant primary sites of electron attachment to proteins, with internal electron migration producing the disulfide radical anion and the imidazole electron adduct. 2 tables, 4 figures.

37806 High molecular weight radiation curable resins. Harrison, S.A. (to General Mills Chemicals, Inc.). US Patent 4,065,627. 27 Dec 1977. Filed date 27 Sep 1976. 18p.

An invention is described relating to high molecular weight radiation curable ester-diethers, ester-monoethers and their diisocyanate derivatives.

37807 Radiation curable coating composition. Prucnal, P.J.; DeMajistre, R. (to PPG Industries, Inc.). US Patent 4,065,624. 27 Dec 1977. Filed date 27 Jan 1976. 24p.

3-Halo-2-hydroxypropyl acrylates and methacrylates and 2-halo-1-(hydroxymethyl)ethyl acrylates and methacrylates are used as reactive solvent for an acrylic or methacrylic terminated polyether resin in radiation curable coating compositions.

RADIOCHEMISTRY AND NUCLEAR CHEMISTRY

HOT-ATOM CHEMISTRY

37808 Characterization of hot chlorine atom reactions with hydrogen. Stevens, D.J.; Spicer, L.D. (Univ. of Utah, Salt Lake City). *J. Phys. Chem.;* **82**: No. 6, 627-632(23 Mar 1978).

The reaction of nuclear recoil generated chlorine atoms with hydrogen to produce hydrogen chloride was studied in the presence of ethylene and iodine scavengers. The yield behavior is presented for this reaction over a relative average translational energy range extending from a lower limit of approximately 0.16 eV determined by the thermal scavenging efficiency of the system to several tens of electron volts. The hydrogen isotope effect for H_2 and D_2 reactants is explored over this same energy range and found to exhibit a cross over from a normal value of 2.3 to an inverse effect of 0.8 as the average reaction energy is increased. The relative kinetic behavior of the isotopic systems is interpreted in terms of a steady state non-Boltzmann formalism and comparison is made with reported results for corresponding fluorine atom reactions.

PROPERTIES OF RADIOACTIVE MATERIALS

REFER ALSO TO CITATION(S) 38177

37809 (BMFT-FB-K—77-01) **Chemical decontamination of reactor components.** Riess, R.; Berthold, H.O. (Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.)). Aug 1977. 60p. (In German). Dep. NTIS (US Sales Only), PC A04/MF A01.

A solution for the decontamination of reactor components of the primary system was developed. This solution is a modification of the APAC- (Alkaline Permanganate Ammonium Citrate) system described in the literature. The most important advantage of the present solution over the APAC-method is that it does not induce any selective corrosion attack on materials like stainless steel (austenitic), Inconel 600 and Incoloy 800.

37810 (CONF-770440—, pp 728-739) **Carbonate chemistry of uranium.** Panson, A.J.; Charles, R.G. (Westinghouse Research and Development Center, Pittsburgh). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

Variations in uranium solution species can significantly impact the uranium solution mining process. We have examined the equilibrium constants available in the literature in order to assess the possibility of uranium solution species variations with practical variations in mining solution composition. We will describe uranium solution species which have been reported in the literature and present results of equilibrium calculations. The calculated relative importance of species as a function of solution composition will be given. In addition, we will present a description of physical chemical methods which we have developed and are using to explore mining solutions for uranium species. Results of analysis of model solutions for uranium carbonate species will be presented. The potential impact on mining operation of variations in uranium solution species will be discussed.

37811 (MLM—2491) **Decontamination of the HEPA filters: July—September 1977.** Luthy, D.F.; Lewis, E.L. (Mound Facility, Miamisburg, Ohio (USA)). 20 Feb 1978. Contract EY-76-C-04-0053. 20p. Dep. NTIS, PC A02/MF A01.

Dissolution parameters (in various reagents) of americium-241 and plutonium-239 oxide mixtures, uranium-233 oxide, neptunium-237 oxide, curium-244, thorium-232 oxide, and plutonium dioxide were determined. The reagents used were various concentrations of NHO_3-HF-H_2SO_4,HNO_3-$(NH_4)_2Ce(NO_3)_6$, HNO_3-HF, and HNO_3. Both simulated contaminated HEPA filter media and actual glovebox filter media from spent filters were used. The maximum decontamination factor achieved was 833 using a six-stage dissolution process. Also, plutonium dioxide was fused with sodium carbonate at various elevated temperatures, and a dissolution percentage was determined.

37812 Radioiodine labelling of insulin using dimethylsuloxide as a labelling-aid. Kim, J.; Kim, Y.H. *J. Korean Nucl. Soc.;* **9**: No. 4, 203-210(Dec 1977).

Using dimethylsulfoxide (DMSO) as a labelling aid, insulin-^{125}I for radioimmunoassay use was prepared. A small amount of DMSO was added to usual labelling mixture and the reaction time was controlled. The labelled insulin obtained in such a way showed improved bindabilities to the antibody and thus expressed larger dose-gradients in the plots of standard dose-response curves even though the labelling rate was decreased to some extent. However, by extending the reaction time to about 1 min, average labelling yield of 30 percent could be obtained. The average increase of bindability (B/F) in definite antiserum dilution was 2.5 comparing with 1.5 obtained in the absence of DMSO. Thus, the net bindability increase was 70 percent of those obtained in the absence of DMSO. By means of NMR spectrometry, it was confirmed that the DMSO in the labelling mixture is converted to dimethylsulfone by chloramine-T. The results, generally agreeing with Stagg's postulation, are discussed in view of a competitive oxidation of DMSO with disulfide linkages of the insulin molecule by the chloramine-T.

37813 Reaction chemistry of actinide organometallics. Grant, C.B. Berkeley, CA; Univ. of California (1977). 147p. University Microfilms Order No. 77-31,376.

Thesis (Ph. D.).

The syntheses of bromocyclooctatetraene, n-butylcyclooctatetraene, bis(eta^8-cyclooctatetraene)uranium(IV), and bis(n-butyl-eta^8-cyclooctatetraene)uranium(IV) (di-n-

butyluranocene) have been improved, and detailed procedures are given. The reactions of aryl and alkyl nitro compounds with di-n-butyl-uranocene give uranium oxides, n-butylcyclooctatetraene, and azo compounds. A working hypothesis for the mechanism has been proposed, but more study is needed before it can be established. The complex formed by treatment of UCl_4 with 18-crown-6 was isolated and treated with n-butylcyclooctatetraene dianion. The metal-containing material is only di-n-butyluranocene, with no evidence that the 18-crown-6 has remained with the metal. An attempt to metallate di-n-butyluranocene with the 18-crown-6 complex of potassium hydride gave only reduction of the uranocene to n-butylcyclooctatetraene dianion, and either uranium metal or a uranium hydride.

RADIOISOTOPE PRODUCTION

REFER ALSO TO CITATION(S) 36940

COMBUSTION CHEMISTRY

REFER ALSO TO CITATION(S) 36733, 37786

37814 (CONF-770561—(Absts.)) **[Technical meeting of the Canadian Section of the Combustion Institute]. Abstracts of papers.** (Calgary Univ., Alberta (Canada). Dept. of Mechanical Engineering). 1977. 21p. Dep. NTIS (US Sales Only), PC A02/MF A01.

From Technical meeting of the Canadian Section of the Combustion Institute; Banff, Canada (26 May 1977).

The 21 abstracts cover such topics as: aerodynamic breakup of droplets, pulsed plasma and laser ignition in engine, methane—CO_2 mixtures as fuel for internal combustion engine, gaseous fuel—air mixtures in compression ignition engines, pulsed combustion, flammability of foamed plastics, combustor design, energy consumption in Canada, coal combustion in opposed-flow diffusion burner, pressure effect on OH + CO reaction, effect of inert gases on flame propagation, detonation by flash photolysis, chemiluminescence of hydrocarbon—air combustion, methane—air combustion kinetics and propagation, collective combustion of droplets, accidental vapor cloud explosions, etc. (DLC)

37815 Model for chemical reaction in the freeboard region above a fluidised bed. Yates, J.G.; Rowe, P.N. *Trans. Inst. Chem. Eng. (London);* **55**: 137-142(Apr 1977).

A model is proposed for a first-order catalytic reaction taking place in the freeboard region above a fluidised bed reactor. The extent of reaction is shown to be a function of the fraction of solids ejected into the freeboard from the wake of gas bubbles bursting at the bed surface under conditions where mass transfer and chemical reaction control the overall conversion. The model is evaluated for a set of realistic operating conditions and the predicted conversions are compared with those to be expected from the fluidised bed itself.

37816 Decomposition of nitrogen oxides in the furnace and gas passages of a steam generator during cooling of the combustion products. Zhikhar, G.I. (Belorussian Polytechnical Inst., Minsk). *Vestsi Akad. Navuk BSSR, Ser. Fiz.-Energ. Navuk;* No. 1, 66-70(1977). (In Russian).

The technique for calculation of the kinetic curve of nitrogen oxides in the furnace and gas passages of steam generators is offered. The treatment of experimental data by the given technique shows that during cooling of ignition products decay of nitrogen oxides occurs.

ENGINEERING

FACILITIES AND EQUIPMENT

REFER ALSO TO CITATION(S) 37369, 37370, 37371, 37392, 37393, 37394, 37403, 37404, 37480, 37481, 37482, 37483, 37484, 37622

37817 (SAND—78-0387) **Impulse from an electrically exploded etched copper mesh.** Duggin, B.W.; Forrestal, M.J.; Butler, R.I. (Sandia Labs., Albuquerque, N.Mex. (USA)). Mar 1978. Contract EY-76-C-04-0789. 11p. Dep. NTIS, PC A02/MF A01.

An impulse simulation technique for radiation-induced material blowoff on layers internal to reentry body shell structures was explored. Etched copper mesh patterns were exploded with current from a capacitor discharge. Impulse intensities between 100 and 500 Pa.s (1000 and 5000 taps) were produced on a simulated shell structure which was separated from the mesh by a 1.25 mm (0.05 in.) air gap.

37818 Problems, properties and performance of static seals. Chivers, T.C.; Hunt, R.P. (Berkeley Nuclear Labs., CA). *CEGB Res.;* No. 6, 26-35(Jan 1978).

Maintaining the integrity of any vacuum or pressure system depends upon the satisfactory performance of the seals between the system and the external environment. Seals take many forms and can be between static components, as in the case of flexible rings between pipe flanges, or between components in relative motion, such as the bearing seal where a ship's propeller shaft passes through the hull. As technology advances there is an increasing trend towards the use of higher temperatures and pressures, and this is certainly true in the development of power-generating plant. Greater demands are being made on seals, and increasing importance is being attached to laboratory testing of proposed materials. Thus it is necessary to improve the understanding of ageing processes in seals and the variation of their physical properties under the conditions of use. A general review of static-seal and seal-leakage research undertaken at Berkeley Nuclear Laboratories is presented. Much of the work in progress has originated from studies of aspects of seal behavior which are of particular relevance to nuclear technology, but the principles evolved may be applied to many kinds of sealing problem. Examples are drawn from conventional generating plant to illustrate some of the features of these studies.

37819 Short-time, high temperature mechanical testing facility. Marion, R.H. (Sandia Labs., Albuquerque, NM). *J. Test. Eval.;* **6**: No. 1, 3-8(Jan 1978).

Design and performance details are given for a facility developed to obtain the mechanical properties under high heating rate or transient temperature conditions and medium strain rates. The system uses self-resistance heating and is applicable to materials possessing electrical resistivities ranging from that of aluminum to that of graphite. Heating rates as high as 2000°K/s in graphite are attained under controlled conditions. Methods of measuring temperature and the effects of expected temperature distributions are discussed. A method for measuring strain during transient temperature conditions to 3000°K is described. Finally, results are presented for the stress-strain behavior of Type 316 stainless steel and ATJ(S) graphite obtained for heating times of few seconds.

37820 Evaporation process and acoustic barriers in sodium heat pipes. Ivanovskii, M.N.; Prosvetov, V.V.; Sorokin, V.P.; Chulkov, B.A.; Yagodkin, I.V. *Inzh.-Fiz. Zh.;* **33**: No. 5, 832-837(Nov 1977). (In Russian).

Heat pipes with compound wicks and sodium as the active medium were studied in an experiment at high levels of thermal flux density, with appropriate shielding provided to achieve such levels. The magnitude of the acoustic barrier to power transfer was measured in special tests, and the experimental results are compared here with theoretical calculations based on an isenthalpic model of mass flow. Friction is taken into account and a shock profile of velocity is assumed. An analysis indicates the possibility of acoustic barriers to appear in capillary form.

37821 Localization of plastic deformation. Rice, J.R. (Brown Univ., Providence). pp 207-220 of Theoretical and applied mechanics. Koiter, W.T. (ed.). Amsterdam; North-Holland Publishing Co. (1976).

From 14. IUTAM congress; Delft, The Netherlands (30 Aug 1976).

The localization of plastic deformation into a shear band is discussed as an instability of plastic flow and a precursor to rupture. Experimental observations are reviewed, a general theoretical framework is presented, and specific calculations of critical conditions are carried out for a variety of material models. The interplay between features of inelastic constitutive description, especially deviations from normality and vertex-like yielding, and the onset of localization is emphasized.

CRYOGENIC AND SUPERCONDUCTING EQUIPMENT AND DEVICES

REFER ALSO TO CITATION(S) 36873, 37260, 37261, 37486, 37713, 38656, 38665

37822 Superconducting fault-current limiter. Gray, K.E.; Fowler, D.E. (Argonne National Laboratory, Argonne, Illinois 60439). *J. Appl. Phys.;* **49**: No. 4, 2546-2550(Apr 1978).

A conceptual design is presented for a fault-current limiter for the electrical power utilities which utilizes a superconducting element to commutate the fault current into a shunt resistor. The technical feasibility of the concept is supported by a computer simulation of the switching. A three-phase 145-kV 2-kA electrical system is considered in detail for ease of comparison with other fault-current limiters. Finally, the important advantages of such a fault-current limiter are pointed out, and the areas of additional research for the immediate future are indicated.

37823 Transient Josephson effect in a Nb_3Sn microbridge. Golovashkin, A.I.; Zurkin, B.G.; Lykov, A.N.; Novikov, V.I. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. Tech. Phys. Lett. (Engl. Transl.);* 3: No. 9, 351-352(Sep 1977).

Nb_3Sn contacts were produced by the double-scribing method. The Josephson effect was studied for the temperature range 13-18.3°K and for the frequency range 9-10 GHz.

HANDLING EQUIPMENT AND PROCEDURES

REFER ALSO TO CITATION(S) 37012, 37401

37824 (NUREG/CR—0004) **SNAKE: a solid angle calculational system.** Thompson, J.K.; Lewallen, M.A.; Trapp, T.J. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Sep 1977. Contract EY-76-C-06-1830. 29p. Dep. NTIS, PC A03/MF A01.

A computer code, SNAKE (Solid Angle Calculational System for Neutron Interaction and Array K-effective Estimation), has been developed for the calculation of solid angles subtended by geometric forms composed of spherical, cylindrical, and planar surfaces, either singularly or in specified arrays, from exact analytic integral forms. This basic capability is used to provide information necessary for the solid angle method for evaluation of neutron interaction in arrays. This document outlines the methodolgy and use of the code.

SHIPPING CONTAINERS

37825 (ORNL—5406) **Safety analysis report for packaging (SARP) of the Oak Ridge National Laboratory Shipping Cask D-38.** Klima, B.B.; Shappert, L.B.; Seagren, R.D.; Box, W.D. (Oak Ridge National Lab., Tenn. (USA)). Apr 1978. Contract W-7405-ENG-26. 120p. Dep. NTIS, PC A06/MF A01.

Portions of document are illegible.

An analytical evaluation of the Oak Ridge National Laboratory Shipping Cask D-38 (solids shipments) was made to demonstrate its compliance with the regulations governing off-site radioactive material shipping packages. The evaluation encompassed five primary categories: structural integrity, thermal resistance, radiation shielding, nuclear criticality safety, and quality assurance. The results of the evaluation show that the cask complies with the applicable regulations.

37826 (ORNL—5408) **Safety analysis report for packaging (SARP) of the Oak Ridge National Laboratory Garden Carrier No. 2.** Klima, B.B.; Shappert, L.B.; Seagren, R.D.; Box, W.D. (Oak Ridge National Lab., Tenn. (USA)). Apr 1978. Contract W-7405-ENG-26. 160p. Dep. NTIS, PC A08/MF A01.

Portions of document are illegible.

An analytical evaluation of the Oak Ridge National Laboratory Garden Carrier No. 2 was made to demonstrate its compliance with the regulations governing off-site radioactive material shipping packages. The evaluation encompassed five primary categories: structural integrity, thermal resistance, radiation shielding, nuclear criticality safety, and quality assurance. The results of the evaluation show that the cask complies with the applicable regulations. The package is designed to ship large quantities of fissile and radioactive materials as solids.

37827 (SAND—78-0309) **Nondestructive evaluation of LWR spent fuel shipping casks.** Ballard, D.W. (Sandia Labs., Albuquerque, N.Mex. (USA)). Feb 1978. Contract EY-76-C-04-0789. 27p. Dep. NTIS, PC A03/MF A01.

An analysis of nondestructve testing (NDT) methods currently being used to evaluate the integrity of Light Water Reactor (LWR) spent fuel shipping casks is presented. An assessment of anticipated NDT needs related to breeder reactor cask requirements is included. Specific R and D approaches to probable NDT problem areas such as the evaluation of austenitic stainless steel weldments are outlined. A comprehensive bibliography of current NDT methods for cask evaluation in the USA, Great Britain, Japan and West Germany was compiled for this study.

37828 Shielded container. Fries, B.A. (to Chevron Research Co.). US Patent 4,081,688. 28 Mar 1978. Filed date 22 Jul 1976. 4p. PAT-APPL-707,805.

A shielded container for transportation of radioactive materials is disclosed in which leakage from the container is minimized due to constructional features including, inter alia, forming the container of a series of telescoping members having sliding fits between adjacent side walls and having at least two of the members including machine sealed lids and at least two of the elements including hand-tightenable caps.

37829 Experience with fabrication and testing of 70-tonne spent fuel shipping casks. Prasad, A.N.; Seetharamiah, P. (Bhabha Atomic Research Centre, Bombay (India)). pp 219-222 of Transport packaging for radioactive materials. Vienna; IAEA (1976).

From Symposium on the design, construction and testing of packaging for the safe transport of radioactive materials; Vienna, Austria (23 Aug 1976).

See CONF-760813—.

It is proposed to transport spent fuel from nuclear power stations to fuel reprocessing plant in 70-tonne shielding casks. Two different types of casks have been designed, details of which were presented at the 1971 IAEA Vienna Seminar on Tests on Transport Packaging for Radioactive Materials. The present paper describes experience gained in the fabrication and subsequent testing of these casks.

37830 Use of scale models to assess structural response of nuclear shipping containers under accident conditions. Robinson, R.A.; Basham, S.J.; Lusk, E.C. (Battelle Columbus Labs., Ohio (USA)). pp 439-444 of Transport packaging for radioactive materials. Vienna; IAEA (1976).

From Symposium on the design, construction and testing of packaging for the safe transport of radioactive materials; Vienna, Austria (23 Aug 1976).

See CONF-760813—.

Experimental scale modelling techniques were used to investigate the complex behaviour of truck-type high level waste and spent fuel shipping packaging during severe impact accidents. A series of experiments were conducted with distorted replica scale models fabricated with Type 304 stainless steel and unbonded lead shielding. The models were fabricated to represent typical 1/8, 1/4, and 1/2 linear scaled versions of a full scale prototype unit. Experiments were conducted for 9m (30 ft) free fall accidents onto an essentially unyielding surface with the centre-of-gravity of the model directly over the centre of its bottom plate. The test temperatures were - 40 and 175°C to cover the extreme environmental conditions that this type of packaging may encounter in its normal service life. The inertial loading of the model was controlled during the simulated impact accident by attaching a balsa wood impact limiter to the bottom of the model. Deceleration measurements obtained during the tests were in the range of 1000g. Permanent strain induced in the steel shells was in the range of 0.004 m/m with the largest strain induced at 175°C as expected. Lead slump occurred in all experiments and was in the range of 1 to 3% of the original shielded length.

37831 Demonstration of the Essor shipping flask's compliance with the radioactivity release limits defined by the IAEA in 1973. Rocco, P. (Commission of the European Communities, Ispra (Italy). Joint Research Centre). pp 325-332 of Transport packaging for radioactive materials. Vienna; IAEA (1976). (In French)

From Symposium on the design, construction and testing of packaging for the safe transport of radioactive materials; Vienna, Austria (23 Aug 1976).

See CONF-760813—.

The 20-tonne shipping flask for fuel elements irradiated in the experimental reactor Essor at Ispra (Italy) has been modified so that it will also transport MTR elements in the near future. The paper describes the calculations performed to demonstrate that the shipping flask complies with the release limits defined by the IAEA in the 1973 Revised Edition of the Regulations for the Safe Transport of Radioactive Materials. The calculations are based on the results of testing under overpressure carried out before technical acceptance and repeated before each loading. No leaks were detected in these conditions. The pressure loss was therefore taken to be equal to the limit of sensitivity of the manometer and was transposed in accordance with various assumptions to the normal conditions of transport and to accident conditions. Compliance with the release limits is ensured.

37832 Transport experience with the NAC-1 radioactive materials shipping cask. Rollins, J.D.; Hoffman, C.C. (Nuclear Assurance Corp., Atlanta, Georgia, USA). pp 249-257 of Transport packaging for radioactive materials. Vienna; IAEA (1976).

From Symposium on the design, construction and testing of packaging for the safe transport of radioactive materials; Vienna, Austria (23 Aug 1976).

See CONF-760813—.

During the first one and one-half years of operation of Nuclear Assurance Corporation's (NAC) four (4) second-generation NAC-1 truck casks, shipments of spent fuel assemblies, fuel rods, and other highly irradiated reactor components have involved over 300,000 cask miles of travel by land, and cask handling at some ten different nuclear facilities. This on-site experience has included the use of various types of auxiliary lifting devices, operational problems with which have identified the need to establish related Quality Assurance procedures in the area of post-fabrication testing. During the course of pre-shipment checkout and testing of the casks minor defects in the upper impact limiter and lower cask shielding wall have been detected and repaired according to procedure. One enroute occur-

rence with the cask in which an emergency response was implemented has emphasized the need for rigid adherence to procedural checkout before shipment. Periodic inspection and testing are performed as part of the cask license requirement whereby cask components are inspected and/or replaced. During such test periods leaking ball valves and a leaking neutron shield tank have been detected and repaired.

37833 Thermal test methods and experience in the Federal Republic of Germany. Schulz-Forberg, B. (Bundesanstalt fuer Materialpruefung, Berlin (Germany, F.R.)). pp 467-479 of Transport packaging for radioactive materials. Vienna; IAEA (1976).

From Symposium on the design, construction and testing of packaging for the safe transport of radioactive materials; Vienna, Austria (23 Aug 1976).

See CONF-760813—.

The European regulatory work for the transport of radioactive materials is based on IAEA Regulations dating from 1964 and 1967. Since 1967 the thermal test for Type B packagings has been a standard requirement in the Federal Republic of Germany. In the past 9 years 53 Type B certificates have been issued for packages with capsuled isotopes such as cobalt 60 of about 20kg weight, for packages containing radioactive waste and for shipping casks containing either irradiated or spent fuel elements up to about 35t. No tests or calculations of thermal behaviour were necessary for certain packagings with capsuled isotopes and for packages validated by certificates. Most of the packagings, however, required tests or calculations; three ways of dealing with this problem are possible. In the Federal Republic of Germany the Bundesanstalt fuer Materialpruefung (BAM) is the competent authority for Type B packagings. On the basis of computer programs and accumulated experience, certain types of packaging are often analysed by BAM at the design stage. In the process of certification the following criteria must be taken into account: the kind of failure, and the cost-benefit analysis. After evaluation one of the following methods can be used: prototype tests with or without measurements; tests with either full-sized prototype specimens or smaller scaled-model specimens, with measurements; computer application only. Photographs and detailed descriptions of examples give an idea of the test equipment, e.g. furnaces used for Test Methods I and II (see IAEA Safety Series No.37, Advisory Material) and equipment used for open fires.

37834 Considerations relating to different types of packaging. Sousselier, Y.; Cohendy, G. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France)). pp 13-18 of Transport packaging for radioactive materials. Vienna; IAEA (1976). (In French)

From Symposium on the design, construction and testing of packaging for the safe transport of radioactive materials; Vienna, Austria (23 Aug 1976).

See CONF-760813—.

The transport of radioactive materials has never given rise to a serious accident in France. This is due to the high quality of the provisions contained in the Regulations and to the conscientious manner in which the latter are applied. However, it would now seem appropriate to re-examine certain of these provisions in the light of a number of minor incidents which have occurred, or merely because problems have arisen which did not exist at the time of the last revision. This applies particularly to Type B packaging, intended for irradiated fuel shipments whose considerable bulk calls for a mock-up study. The transport of Type B packaging by sea may pose the problem of its resistance to fire on normal merchant ships, and similarly its behavior under the effect of crushing should be examined in the context of air transport. Industrial-type packaging likewise presents problems, although these are basically of a psychological nature. This is particularly the case with consignments of uraniferous concentrates, uranium hexafluoride and plutonium-contaminated wastes. The accumulation (which sometimes reaches substantial numbers) of Type A packaging on a single vehicle may involve consequences which also call for study.

37835 Leakage tests for Type B packages. Taylor, W.R. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). pp 261-268 of Transport packaging for radioactive materials. Vienna; IAEA (1976).

From Symposium on the design, construction and testing of packaging for the safe transport of radioactive materials; Vienna, Austria (23 Aug 1976).

See CONF-760813—.

Subcommittee N14.5 of the American National Standards Institute (ANSI) has formulated a standard entitled "Leakage Tests on Packages for Shipment of Radioactive Materials". In November 1974, a draft standard was issued for trial use and comment for a period of one year. This paper reviews the status of the standard with the intention of stimulating feed-back information for inclusion into the standard. At Chalk River, a packaging is being developed for fissile material. Radioactive material containment is a prime concern. It was necessary to perform a leakage test procedure that was not listed in the standard in order to demonstrate the containment integrity of the package. This paper describes the package leakage tests and illustrates why information about leakage tests on actual or prototype packages is required for the advancement of the standard.

37836 Collapse test of a model shipping cask under high external pressure. Terada, O.; Akiyama, H.; Iwaki, T. (Mitsui Shipbuilding and Engineering Co. Ltd., Tokyo (Japan)). pp 303-311 of Transport packaging for radioactive materials. Vienna; IAEA (1976).

From Symposium on the design, construction and testing of packaging for the safe transport of radioactive materials; Vienna, Austria (23 Aug 1976).

See CONF-760813—.

A collapse test under high external pressure was carried out on a 1/4 scale model of an 80-ton spent-fuel shipping cask, on the supposition that it had dropped into the sea by accident. Determination of the critical pressure of the model and clarification of its structural behaviour before collapse are emphasized as the aim of this first-step study on the externally loaded cask. A pressurized water tank was used to apply the pressure load to the model cask. Structural deflections and strains at the principal points of the inner and outer shells, and the pressure inside the model, were measured, with the increase in external pressure up to the maximum of 500kgf/cm^2. The progressive deformation and the collapse behaviour of the model, partially filled with cooling water, are discussed like those of a composite structure of two coaxial steel shells with a shielding lead layer between them. To clarify the contribution of each structural component, especially that of the lead, the test results are discussed with reference to the results of finite element calculations. New information and data were obtained on the deformation behaviour, the effect of the resistivity of the lead, and the critical pressure for collapse of the model cask under external pressure.

TRANSPORT AND STORAGE FACILITIES

37837 New repair technique speeds Australian pipeline. Scott, W.E. *Energy Int.;* **14**: No. 8, 13-15(Aug 1977).

By adopting a new in-situ technique for the repair of welds on a large diameter gas pipeline, Australian engineers have achieved considerable economies and minimized delays in bringing a major section of the country's pipeline grid into service.

37838 Study on the strength of the longitudinal hull griders of oil tankers in waves. Nagamoto, R.; Aikawa, N.; Tsukamoto, O.; Matsuyama, M. (Nagasaki Shipyard and Engine Works). *Tech. Rev., Mitsubishi Heavy Ind.;* **13**: No. 3, 241-256(Oct 1976).

The statistical values of wave-induced stress on the hull girder are generally used for evaluation of the longitudinal strength of the hull, and the square root method is often used as an approximate method. However, to obtain the actual predicted values, they should be calculated using the combined stresses due to vertical and lateral loads considering the phase lag of those in the regular waves instead of getting the statistical values of each load. A computer program was developed to evaluate the longitudinal strength of hull girder directly according to the latter method. Using this system, the stress analysis of hull girder on the 210,000 DWT oil tanker was carried out. The outline of this computer program and assumptions for the calculations are described. The main conclusions derived are: comparison of the statistical stress values from the above two methods were carried out and it was found that the values from the approximate method agree well with those derived from a direct method, i.e., the approximate method seems very useful for the designer; the statistical normal stresses at bilge and gunnel are almost the same level and larger than those of deck and bottom centerline by 30% at maximum under full load condition; in general, the normal stresses in full load conditions are larger than those in ballast load condition because the lateral bending moment in the full load condition is larger than that in ballast condition according to the difference of draft; the maximum normal stress occurs at the gunnel of leeward side and the bilge of weather side in the quartering sea and at the wave length $\sqrt{L}/\text{lambda} = 1.3—1.4$; and the ship velocity contributes little to reduction of the maximum stress.

MINING AND DRILLING EQUIPMENT AND FACILITIES

REFER ALSO TO CITATION(S) 36709

LASERS

37839 (COO—4223-1) **Investigation of concept of efficient short wavelength laser. Quarterly progress report, 1 April 1977—30 June 1977.** Piper, L.G.; Taylor, R.L. (Physical Sciences, Inc., Woburn, Mass. (USA)). 1 Aug 1977. Contract EC-77-C-02-4223. 24p. (PSI-TR—98). Dep. NTIS, PC A02/MF A01.

An experiment was designed to study the wavelength-selected photolysis of gaseous, covalent azides. The apparatus for these

studies is described. The azides are to be photolyzed by light from a doubled dye laser, and the photolysis fragments probed by laser-induced fluorescence (LIF) or by the observation of photon emission. Kinetics of the photolysis fragments may be studied by precisely controlling the time between the pulses from the photolysis and probe lasers. In such a system we shall be able to determine the product yields from the photolysis, the kinetics of the electronically excited fragments, and the spectroscopy of the photolysis fragments. The latter measurement is accomplished by scanning the fragment fluorescence spectrum with a monochromator, or by scanning the probe laser over the absorption bands of the fragment molecules. The problems of scattered laser light and techniques to reduce them are discussed in detail. Calculations have been performed to simulate typical experimental conditions to be expected in studies on the photolysis of HN_3. Typical fragment densities are calculated along with the signals expected from the LIF diagnostic. Several experimental problems, such as fluorescence quenching and diffusion, are discussed in detail. It is concluded that the proposed experimental design will have sufficient sensitivity and flexibility to perform the experiments.

37840 (LA—6955) **LAPU2: a laser pulse propagation code with diffraction.** Goldstein, J.C.; Dickman, D.O. (Los Alamos Scientific Lab., N.Mex. (USA)). Mar 1978. Contract W-7405-ENG-36. 79p. Dep. NTIS, PC A05/MF A01.

Complete descriptions of the mathematical models and numerical methods used in the code LAPU2 are presented. This code can be used to study the propagation with diffraction of a temporally finite pulse through a sequence of resonant media and simple optical components. The treatment assumes cylindrical symmetry and allows nonlinear refractive indices. An unlimited number of different media can be distributed along the propagation path of the pulse. A complete users guide to input data is given as well as a FORTRAN listing of the code.

37841 (UCRL—50021-76, pp 6.1-6.83) **Advanced lasers.** Jun 1977.

In Laser Program annual report, 1976.

Research progress is reported on laser developments for laser fusion and laser isotope separation. (TFD)

37842 Electron drift velocities in helium-fluorine gas mixtures. Nygaard, K.J.; Fletcher, J.; Hunter, S.R.; Foltyn, S.R. (Department of Physics, University of Missouri-Rolla, Rolla, Missouri 65401). *Appl. Phys. Lett.;* **32**: No. 10, 612-613(15 May 1978).

Using a simple time-of-flight technique, we have measured the electron drift velocity in helium with 0.1-1% fluorine additive. Our results in a 0.1% mixture are in close agreement with data in pure helium. The measured drift velocity increases with increasing fluorine concentration.

37843 Radiative lifetime and quenching of KrF. Quigley, G.P.; Hughes, W.M. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Appl. Phys. Lett.;* **32**: No. 10, 627-629(15 May 1978).

Excitation of atomic krypton in the presence of molecular fluorine by a wavelength-selective 2.5-ns-long argon excimer photolytic source was used to initiate the reaction sequence resulting in the formation of excited KrF. The radiative lifetime of the KrF^* laser transition was found to be 9 ns at the high-pressure limit. This is in good agreement with the calculated values. The rate constant for two-body quenching of KrF^* by F_2 is $5.7 \pm 0.5 \times 10^{-10}\ cm^3\ s^{-1}$ and the rate constant for three-body quenching by Kr is $2.9 \pm 0.3 \times 10^{-31}\ cm^3\ s^{-1}$.

37844 Faraday effect in Hg/sub 1-x/Cd/sub x/Te at CO_2 laser wavelengths. Ahrenkiel, R.K.; Weiss, P.; Watkins, D.; Gulati, S.K.; Grannemann, W.W. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *J. Appl. Phys.;* **49**: No. 4, 2265-2267(Apr 1978).

The optical and magneto-optical properties of crystals of Hg/sub 1-x/Cd/sub x/Te (x=0.37) have been measured over the CO_2 laser wavelength region. The absorption edge of this composition occurs at about 3.2 μm, and the Faraday rotation consists of interband and intraband components. The latter is very large in n-type material due to the small electron effective mass (0.052). The figure of merit of n-type material is about 1.0 deg/kOe at 10.6 μm. Optical-damage studies give a damage threshold of 160 MW/cm², indicating application to high-power laser isolator devices.

37845 Automatic bias control circuit for injection lasers. Albanese, A. (to Bell Telephone Labs., Inc.). US Patent 4,081,670. 28 Mar 1978. Filed date 8 Nov 1976. 8p.

An injection laser is automatically stabilized so that the laser operates above threshold when the laser current is modulated. The invention makes use of the fact that the laser junction voltage saturates at currents above the threshold. A signal which modulates the laser current and causes the laser current to fall below the threshold level therefore results in a change in the junction voltage. These changes in the junction voltage are monitored and used to increase the bias current so that the laser operates above threshold.

37846 Etalon laser mode selector. Berg, A.D. (to Coherent, Inc.). US Patent 4,081,760. 28 Mar 1978. Filed date 3 Jun 1976. 8p.

A Fabry-Perot etalon is mounted within the optical cavity of a laser for selecting the wavelength of the output radiation of that laser from a plurality of discrete wavelengths closely distributed about a nominal wavelength. The etalon includes a pair of closely spaced prisms mounted along the optical axis of the laser cavity with the laser beam passing therethrough. Each of the prisms has a first surface facing outwardly of the etalon and inclined at a slight angle to a normal to the optical axis, and each prism includes a second surface optically adjacent and spaced from the second surface of the other prism, each such second surface being inclined relative to its respective first surface.

37847 Enhanced laser pumping by auxiliary luminescent centers that absorb and transfer normally wasted pump energy to the laser ion. Melamed, N.T.; Hirayama, C. (to Westinghouse Electric Corp.). US Patent 4,081,761. 28 Mar 1978. Filed date 11 Aug 1969. 6p.

Sensitizer impurities absorb a portion of pump radiation in a laser generator that is not absorbed by the activator impurity. The sensitizer transfers the otherwise wasted radiation to the activator impurity. Mn^{+2}, UO_2^{+2} and Ce^{+3} are examples of sensitizer ions. The foregoing sensitizer ions may, in turn, be sensitized by other impurities, known as cosensitizers to further utilize pump radiation.

37848 Gas laser with a laser capillary positioned in a discharge tube. Golser, H.; Kindl, H. (to Siemens AG). US Patent 4,081,762. 28 Mar 1978. Priority date 18 Feb 1975, German, Federal Republic of (F.R. Germany). 10p.

A gas laser having a vacuum-tight discharge tube characterized by the discharge tube consisting of a glass cylinder whose two ends are closed by metal caps is described. Each of the metal caps support a mirror member which is connected to a transition member by a glass solder connection. A laser capillary which is made of glass has one end fused to the glass cylinder and has its other end supported by a spring which consists of a material which has a high heat resistance and may be hardened after assembly with the laser capillary and discharge tube. The laser capillary has a portion surrounded by a cold cathode which is disposed in the interior of the discharge tube and consists of a rolled sheet of resilient metal which tightly engages the inner surface of the discharge tube due to its own resilient spring force.

37849 Method and apparatus for providing a calibrated scan for a scanning laser. Berg, A.D.; Wise, W.L. (to Coherent, Inc.). US Patent 4,081,765. 28 Mar 1978. Filed date 3 Jun 1976. 10p.

An apparatus and a method are disclosed for continuously varying the output radiation frequency of a scanning laser system about a selected nominal output radiation frequency with a calibrated scan. Apparatus is disclosed for continuously varying the resonant frequencies of both the laser cavity and the reference cavity, for controlling this scanning and for calibrating the scan width. A method for calibrating the scan width is also disclosed.

37850 Electroluminescent laser. Vlasenko, N.A.; Pukhly, Z.A. US Patent 4,081,763. 28 Mar 1978. Filed date 19 Jan 1977. 6p.

A solid-state laser is described in which an inverse population is formed at the levels of dope ions of the elements with unfilled electron shells by means of impact excitation of said ions with hot carriers, made on the basis of an electroluminescent capacitor in which the layer of electroluminescent substance is optically homogeneous, doped with said elements, and serves as the active element of the laser. The electrodes of the capacitor perform the functions of the Fabry-Perot cavity mirrors and those of the electrodes in order to produce the electrical field required to excite the active element. One of these electrodes is partially transparent to the laser emission.

37851 D.C. excitation of high pressure gas lasers. Farish, O.; Hundstad, R.L.; Pack, J.L. (to Westinghouse Electric Corp.). US Patent 4,080,578. 21 Mar 1978. Filed date 6 Apr 1976. 12p.

A gas laser system with moderate speed gas glow through the optical cavity to facilitate dc excitation of the gas to lasing levels is described. An electrode assembly is positioned so as to provide a glow discharge transverse to the optical axis within the optical cavity when a high dc voltage is applied. By maintaining the high rate of flow of gas through the cavity, the glow discharge is stabilized while the gas medium is maintained at high pressure. Proper choice of electrode geometry and flow rate of the gas through the optical cavity allows the laser system to operate at pressures from a few Torr to atmospheric pressure and above thereby producing a high power c-w output.

37852 Laser fusion pulse shape controller. Siebert, L.D. (to KMS Fusion, Inc.). US Patent 4,061,985. 6 Dec 1977. Filed date 16 Jan 1976. 6p.

An apparatus for controlling the pulse shape, i.e., the pulse duration and intensity pattern, of a pulsed laser system, and which is particularly well adapted for controlling the pellet ignition pulse in a laser-driven fusion reaction system. The apparatus comprises a laser generator for providing an optical control pulse of the shape desired, a pulsed laser triggered by the control pulse, and a plurality of optical Kerr-effect gates serially disposed at the output of the pulsed laser and selectively triggered by the control pulse to pass only a portion of the pulsed laser output generally correspondng in shape to the control pulse. 7 claims, 1 figure.

37853 Nanosecond and microsecond pulse generation in solid-state lasers (review). Arsen'ev, V.A.; Matveev, I.N.; Ustinov, N.D. *Sov. J. Quant. Electron. (Engl. Transl.);* **7**: No. 11, 1321-1332(Nov 1977).

The temporal characteristics of Q-switched laser pulses are considered. The dependences are given of the duration (Δtau) and shape of pulses from solid-state lasers, operating in the giant-pulse regime, on the active-medium and resonator parameters, and the possibilities of varying Δtau over the range 10^{-9}-10^{-6} sec are considered. Attention is concentrated on the possibilities of increasing the duration of a pulse to 1 μsec and more. Theoretical and experimental results are presented on the subject of increasing the pulse duration by introducing, into the laser cavity, electro-optic negative feedback or nonlinear losses caused by two-photon absorption in semiconductors, stimulated Raman scattering, and second harmonic generation. Methods are also considered of reducing Δtau for a giant pulse to 10^{-9} sec or less.

37854 Yttrium aluminum garnet master oscillator and formation of the spectral composition of high-power laser radiation. Zorev, N.N.; Sklizkov, G.V.; Tsvetkov, M.Y.; Shikanov, A.S. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* **7**: No. 11, 1340-1345(Nov 1977).

An investigation is made of the characteristics of formation of the spectrum of high-power laser radiation using two types of oscillator: neodymium-glass and an yttrium aluminum garnet (YAG). A description is given of an active Q-switched neodymium-doped YAG oscillator. Its parameters are presented and their importance for the operation of a high-power laser is considered. It is shown that appreciable broadening of the radiation spectrum of the YAG oscillator during amplification may be caused by the stimulated emission of weak broad-spectrum directional radiation in addition to a narrow high-intensity line.

37855 Optimization of the parameters of a pulsed CO_2 laser. Burtsev, V.A.; Kondakov, A.A.; Timonin, A.M.; Shanskii, V.F. *Sov. J. Quant. Electron. (Engl. Transl.);* **7**: No. 11, 1357-1359(Nov 1977).

The simplex method is employed to optimize the operating conditions of a pulsed CO_2 laser excited by a nonself-sustained discharge. It is found that for the given laser design the maximum specific energy output attains 80-90 $Jxliter^{-1}xatm^{-1}$ for a pulse duration of 8 μsec and a specific energy input of 430 $Jxliter^{-1}xatm^{-1}$.

37856 Determination of the stimulated emission cross section of neodymium glasses by measurement of the absorption from the thermally populated ^{4}I/sub 11/2/ levels. Ageeva, L.E.; Brachovskaya, N.B.; Lunter, S.G.; Przhevuskii, A.K.; Tolstoi, M.N. *Sov. J. Quant. Electron. (Engl. Transl.);* **7**: No. 11, 1379-1382(Nov 1977).

The temperature dependence of the intensity of the absorption band corresponding to the ^{4}I/sub 11/2/→^{4}F/sub 3/2/ transition was measured for the neodymium glasses GLS-3 (silicate) and GLS-24 (phosphate) in the range of 300-720°K. The data were used to calculate the stimulated emission cross sections $\sigma_0 = 1.7 \times 10^{-20}$ cm^2 (GLS-2, GLS-3) and $\sigma_0 = 3.3 \times 10^{-20}$ cm^2 (GLS-21, -22, -23, -24). This investigation, together with a comparison with the results of measuring the cross section σ_0 by other spectroscopic methods, suggested that the integrated intensity of the ^{4}F/sub 3/2/→^{4}I/sub 11/2/ transition was practically unaffected by a considerable variation in the populations of the levels governing the fine structure. It was found by two independent methods that the absorption of Nd^{3+} ions at 1.06 μ at T=300°K was 3×10^{-4} cm^{-1} (GLS-3) and 6×10^{-4} cm^{-1} (GLS-24).

37857 Influence of mirror deformation on the characteristics of lasers with unstable resonators. Konev, Y.B.; Feofilaktov, V.A. (Institute of High Temperatures, Academy of Sciences of the USSR, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* **7**: No. 11, 1398-1400(Nov 1977).

A numerical solution of a transcendental equation, representing the condition of steady-state stimulated emission from lasers with unstable resonators subject to an allowance for changes in the resonator parameters because of thermoelastic mirror deformation, is used to study the dependence of the output power on the coupling coefficient of the undeformed resonator and on the characteristics of the active medium and mirrors.

37858 Compact electron-beam-controlled CO_2 laser with sealed electron guns. Vol'ter, V.G.; Minaev, A.N.; Sviridov, A.N. *Sov. J. Quant. Electron. (Engl. Transl.);* **7**: No. 11, 1419-1420(Nov 1977).

An investigation was made into the possibility of constructing a compact electron-beam-controlled laser. The working gas was ionized by sealed IMAZ-150E tubes which projected 1.5×10^{12} electrons into the atmosphere in 10^{-8} sec. A laboratory laser system was constructed in which an electron beam was injected into a discharge chamber at right-angles to the axis of the main discharge. The dimensions of the active region were 1.0 x 4.5 x 26 cm and the size of the laser, including the pulse power supply of the electron guns, was 10 x 37 x 60 cm. When the pressure in the working mixture was 1 atm, the output radiation energy was 2 J and the efficiency was 20%.

37859 Optically pumped subnanosecond dye laser. Brueckner, F.; Dneprovskii, V.S.; Chumash, V.N. (M. V. Lomonosov Moscow State University). *Sov. Tech. Phys. Lett. (Engl. Transl.);* **3**: No. 10, 418-419(Oct 1977).

A rhodamine 6G laser is described which is pumped by the second harmonic of the output from a yttrium-aluminum garnet mode-locked laser.

37860 Electron-beam stabilized XeF laser. Bychkov, Y.I.; Karlov, N.V.; Konovalov, I.N.; Mesyats, G.A.; Prokhorov, A.M.; Tarasenko, V.F. *Sov. Tech. Phys. Lett. (Engl. Transl.);* **3**: No. 10, 427-428(Oct 1977).

The output energy characteristics of XeF laser are reported.

37861 Electric-discharge XeF laser. Isakov, I.M.; Lenov, A.G.; Ogluzdin, V.E. (M. V. Lomonosov Moscow State University). *Sov. Tech. Phys. Lett. (Engl. Transl.);* **3**: No. 10, 438-439(Oct 1977).

The energy characteristics and efficiency of a XeF laser operating at atmospheric pressure are investigated.

37862 High-power, high-pressure laser based on red fluorine lines. Lisitsyn, V.N.; Razhev, A.M. (Institute of the Physics of Semiconductors, Siberian Branch, Academy of Sciences of the USSR, Novosibirsk). *Sov. Tech. Phys. Lett. (Engl. Transl.);* **3**: No. 9, 350-351(Sep 1977).

Experimental results on a high pulsed power He:NF_3 laser are reported. Five new lasing lines are noted in the range 0.6-0.75 μ.

37863 Beats in a solid-state ring laser with a nonlinear absorber. Dotsenko, A.V.; Lariontsev, E.G. (M. V. Lomonosov Moscow State University). *Sov. Tech. Phys. Lett. (Engl. Transl.);* **3**: No. 9, 366-367(Sep 1977).

It is proposed that an absorbing cell in the resonator be used to achieve a stable beat regime.

37864 Relative threshold current density of stripe-geometry AlAs-GaAs heterojunction lasers with oxygen implantation. Kolyshkin, V.I.; Portnoi, E.L. (A. F. Ioffe Physicotechnical Institute, Academy of Sciences of the USSR, Leningrad). *Sov. Tech. Phys. Lett. (Engl. Transl.);* **3**: No. 9, 388-390(Sep 1977).

The threshold properties of heterojunction lasers were studied experimentally as functions of oxygen ion radiation dose and stripe width. The ions had an energy range of 3.1-5.5 MeV.

37865 Excitation of a XeF laser with a longitudinal electric discharge. Isakov, I.M.; Leonov, A.G.; Ogluzdin, V.E. (M. V. Lomonosov Moscow State University). *Sov. Tech. Phys. Lett. (Engl. Transl.);* **3**: No. 9, 397-398(Sep 1977).

The laser ultraviolet radiation emitted when a mixture of He, Xe, and NF_3 is excited by a high-voltage longitudinal discharge is studied.

37866 Effect of the temporal characteristics of a semiconductor laser on the accuracy of a distance measurement by means of a pulsed-phase phototachymeter in which it is used. Bryskina, I.V.; Deryagin, V.N.; Marasin, L.E.; Popov, Y.V. *Sov. J. Opt. Technol. (Engl. Transl.);* **44**: No. 8, 491-493(Aug 1977).

This paper presents the results of experiments that demonstrate a close relationship between the temporal nonuniformity of the near radiation field of injection lasers and the distance measurement errors of phototachymeters in which they are used. The use of lasers having dual heterostructures, the temporal nonuniformity of which does not exceed 0.5-1.5 nsec, is shown to be a promising approach.

37867 Laser containing a laser resonator. Cremosnik, G. (to Werkzeugmaschinenfabrik Oerlikon-Buhrle AG). US Patent 4,024,466. 17 May 1977. Priority date 28 Aug 1974, Switzerland. 6p.

A laser containing a laser resonator possessing a laser rod and an electro-optical modulation device between two mirrors is described. The modulation device comprises a polarization element and a component embodying an electro-optical crystal at the opposite faces of which there are arranged electrodes. Both faces of the crystal and a polarization prism of the polarization element possess a degree of planeness less than one-tenth of the wavelength of the

laser light and with respect to one another a plane-parallelism of less than five arc seconds for increasing the stored energy in the laser resonator and the power output.

37868 Generation of corona for laser excitation. Farish, O.; Hundstad, R.L. (to Westinghouse Electric Corp.). US Patent 4,024,465. 17 May 1977. Filed date 1 Jul 1975. 6p.

A gas laser tube apparatus for producing a high-current glow, arc or spark which generates initiatory electrons and charged particles for establishing excitation of gas molecules in a separate region of the tube is described. Separate regions of ionization and excitation are established so that uniformity of excitation, optimization of the ratio of electric field intensity to electron density (E/N) and uniform intensity of excitation can be obtained in a high pressure gas laser system independent of ionization or initiation of discharge which also may need to be optimized. The separate fields are achieved by proper configuring of the electrodes with appropriate voltages applied thereto.

37869 Superradiance kinetics of a γ-ray laser. Andreev, A.V. (Moscow State University). *Sov. Phys. - JETP (Engl. Transl.);* **45**: No. 4, 734-739(Apr 1977).

An analysis is made of the kinetics of a single-pass mirror-free γ-ray laser. The conditions governing the operation of this laser are obtained. The possibility of Dicke superradiance in the γ-ray range is estimated. The analysis is carried out for single-mode emission from a system of two-level nuclei.

37870 Use of electrochemical reactions in dye lasers. Rubinov, A.N.; Tomin, V.I. *Acta Univ. Szeged., Acta Phys. Chem.;* **23**: No. 2-3, 235-242(1977). (In Russian).

The possibility of producing population inversions between the electronic states of organic molecules using electrochemical reactions in solutions is analyzed. The population of the first singlet excited states is estimated on the basis on the power of electrochemiluminescence (ECL), and the extent of radiative volume. To increase the population of the excited singlet states a stimulation by acoustic field and with help of oncoming flow of radicals is suggested. The second part contains some experimental results of electrochemical control of dye laser properties in case of usual light pumping.

37871 High efficiency flashlamp pumped dye laser. Anufrik, S.S.; Zabirko, S.P.; Morozov, I.A.; Mostovnikov, V.A.; Motkin, V.S.; Rubinov, A.N.; Rusetzki, A.M. *Acta Univ. Szeged., Acta Phys. Chem.;* **23**: No. 2-3, 249-257(1977). (In Russian).

Investigations are described to find an experimental model of the high efficiency tunable dye laser, pumped by commercial flashlamps. The fundamental parameters of a realized dye laser and its properties under different conditions are given.

37872 Generation of spectrally tunable light pulses in the picosecond domain with applications to spectroscopy. Royt, T.R. College Park, MD; Univ. of Maryland (1976). 163p. University Microfilms Order No. 77-10,419.

Thesis (Ph. D.).

Research directed at extending dye laser technology and demonstrating the utility of the extensions in the conduct of studies of nonlinear optics, spectroscopy, and energy transfer is described. In particular a source was constructed that provided two independent, freely tunable, modelocked pulses with known and adjustable degrees of temporal overlap. The implications for studies and use of mixed frequency parametric interactions in the overlapped case and for time resolved energy transfer studies in the temporally delayed case are staggering. Until now, experiments like these, in the picosecond domain, relied upon a fortuitous coincidence of a fixed laser line with a resonance and/or the selection of a Raman scattering medium which might yield a frequency close to the desired one. The technique for synchronizing two independent, modelocked lasers so that their pulses could be overlapped or delayed with picosecond accuracy made use of grain forced modelocking or synchronous modelocking. By using the same modelocked pump to drive two synchronously modelocked dye lasers, two independently tunable trains of pulses were formed whose pulses were synchronized in time.

HEAT TRANSFER AND FLUID FLOW

REFER ALSO TO CITATION(S) 37369, 37380, 37381, 37458, 37459

37873 (UCRL—78493) **Examination of fluid droplet collisions.** Hendricks, C.D.; Robinson, K.S.; Calliger, R.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 20 Oct 1976. Contract W-7405-ENG-48. 27p. (CONF-7610143—1). Dep. NTIS, PC A03/MF A01.

From Fall meeting of the division of nuclear physics; East Lansing, MI, USA (28 Oct 1976).

A droplet production system has been devised to examine the collisions and coalescence of droplets of water with diameters ranging from 180 to 530 μm. The system consists of two droplet generators each utilizing classical Rayleigh instability induced on a column of flud by a piezoelectric crystal to produce a stream of uniform droplets. The generators can control the charge on the droplets and are capable of electrostatically pulsing a single droplet from the stream. Collision profiles are photographed with a high speed 16mm camera for subsequent examination and analysis.

37874 Effect of thermal flux and pressure on heat transfer during develop nucleate pool boiling of helium. Andreev, V.K.; Deev, V.I.; Kondratenko, A.K.; Petrovichev, V.I.; Keylin, V.E.; Kovalev, I.A. *Inzh.-Fiz. Zh.;* **33**: No. 5, 828-831(19 Jan 1977). (In Russian).

Nucleate boiling of helium under pressures ranging from 0.033 to 0.213 MPa was studied in an experiment with two different heater surfaces: a copper surface with a class 13 finish in a horizontal upward or in a vertical position and an aluminum surface with a class 10 finish in a horizontal upward position only. The test data have been evaluated so as to reveal the dependence of the heat transfer coefficient, in each case, on the magnitude of the thermal flux and on pressure relative to critical. These relations are found to follow generally the same trend as in the case of conventional liquids such as water or organic fluids, and also to be similarly affected by the surface roughness.

37875 Solution of the direct problem of two-phase flow in a laval nozzle within the scope of the two-fluid model. Kopchenov, V.I.; Kraiko, A.N. *Fluid Mech. - Sov. Res.;* **6**: No. 2, 16-30(1977).

The direct problem of the flow of a mixture of gas and foreign particles in the subsonic, transonic and supersonic sections of a plane- or axisymmetric- Laval nozzle is analyzed within the framework of the two-fluid (two-velocity and two-temperature) model of a continuous medium. The problem is solved numerically using, in the integration of the equations for the two-dimensional unsteady flow of the two-phase mixture, a process of stabilization in time.

37876 Experimental and theoretical analysis of void fraction dynamics in a boiling channel. Romberg, T.M. (Australian Atomic Energy Commission, Lucas Heights). pp 85-91 of Second Australasian conference on heat and mass transfer. Sydney; Univ. of Sydney (1977).

An experimental and theoretical investigation of the void fraction dynamics at the exit of a test boiling channel which is operated near the "instability threshold power" (the power level at which coolant flow instabilities occur) is described. Dynamic measurements of the perturbations in channel inlet flow-rate, power input and exit void fraction are analysed using multivariate spectral analysis. The resulting experimental cross-spectral density functions between flow-rate/exit void fraction and power input/exit void fraction agree favorably with those calculated by a linearized hydrodynamic model in the frequency domain.

37877 Improvement in the calculation of turbulent friction in rectangular ducts. Jones, O.C. Jr. (Brookhaven National Lab., Upton, NY). *J. Fluids Eng.;* **98**: 173-181(Jun 1976).

Frictional pressure drop in rectangular ducts is examined. Using correspondence between theory and experiment in laminar flow as a means for acceptance of published data, turbulent flow data for smooth rectangular ducts were compared with smooth circular tube data. Data for ducts having aspect ratios between unity and 39:1 were obtained in the literature and, in conjunction with new experimental data, were examined for deviations from the smooth circular tube line (smooth Moody). It was found that at constant Reynolds number based on hydraulic diameter the friction factor increases monotonically with increasing aspect ratio. It was thus concluded that the hydraulic diameter is not the proper length dimension to use in the Reynolds number to insure similarity between the circular and rectangular ducts. Instead, it was determined that if a modified Reynolds number Re^* was obtained so that geometric similarity was provided in laminar flow by the relation $f = 64/Re^*$ for all geometries, that this Reynolds number also provided good similarity in fully developed turbulent flow within an approximate 5 percent scatter band about the smooth tube line. By using this "laminar equivalent" Reynolds number, Re^*, it is demonstrated that circular tube methods may be readily applied to rectangular ducts eliminating large errors in estimation of friction factor.

37878 Turbulent heat transfer in pipe flows of gas-conveyed solids. Shrayber, A.A. *Heat Transfer - Sov. Res.;* **8**: 60-67(May 1976).

Experimental data obtained by several authors on heat transfer between a gas suspension and the channel walls are analyzed and compared with the heat transfer model developed by the author. The values of three constants governing the rate of heat transfer in

the flow of suspensions of solids are calculated. The model correlates most published test data over a wide range of variables.

MATERIALS TESTING

REFER ALSO TO CITATION(S) 36919, 37650, 37724, 37827

37879 (ANL/MSD—78-2) **Nondestructive evaluation techniques for high-temperature ceramic components. Quarterly report, October—December 1977.** (Argonne National Lab., Ill. (USA)). Feb 1978. Contract W-31-109-ENG-38. 11p. Dep. NTIS, PC A02/MF A01.

The overall objective of this program is to assess and develop nondestructive evaluation procedures for high-temperature ceramics. The program is currently evaluating ceramic heat-exchanger tubing. Ceramic heat exchangers would be useful, for example, in coal-fired Brayton conversion or waste heat-recovery systems. The use of ceramic heat exchangers will allow working fluids to reach temperatures up to 1230°C, and, with further materials development, possibly 1650°C. If superalloys were employed, working fluids would be limited to approximately 800°C. The use of working fluids at higher temperatures would result in more efficient systems. Furthermore, ceramic components are lighter than metallic ones and are made from less costly and more abundant elements. In addition, ceramic heat exchangers would be more resistant to corrosion. In the current NDE effort, several acoustic, optical, and radiographic techniques are being examined for their effectiveness in testing silicon carbide tubing. Some results employing dye-enhanced radiography are discussed.

37880 (LA—7105-MS) **Preprocessing of PHERMEX flash radiographic images.** Brolley, J.E. (Los Alamos Scientific Lab., N.Mex. (USA)). Apr 1978. Contract W-7405-ENG-36. 20p. Dep. NTIS, PC A02/MF A01.

Preparation of PHERMEX images for optimal viewing and/or interactive mensuration is considered. Physiological factors are discussed and then remapping of image density and redistribution of spectral power by sequency analysis are demonstrated.

37881 Measuring the thermal expansion of solids with strain gages. Poore, M.W.; Kesterson, K.F. (Oak Ridge Y-12 Plant, TN). *J. Test. Eval.;* **6**: No. 2, 98-102(Mar 1978).

A technique was developed to measure the thermal expansion of solids in the temperature range from -50 to 175°C. The technique uses strain gages to measure expansion and Type J (iron/constantan) thermocouples to measure temperature. Measurements were made on pure platinum and on copper and tungsten standard reference materials. The maximum difference between measurements made in this study and the certified values was 0.26 x 10^{-6}/°C for the mean coefficients and 0.40 x 10^{-6}/°C for the instantaneous coefficients. The standard deviation of the measurements of the mean coefficients was 0.11 x 10^{-6}/°C. 5 figs. 2 tables.

37882 Impact three-point bend testing for notched and precracked specimens. Server, W.L. (Fracture Control Corp., Goleta, CA). *J. Test. Eval.;* **6**: No. 1, 29-34(Jan 1978).

Testing and data analysis procedures developed from a recently completed fracture toughness testing program on ferritic nuclear pressure vessel steels are presented. These procedures describe the measurement of dynamic fracture toughness at stress intensification rates near 10^5 MPa$\sqrt{m}$/s using instrumented impact testing of three-point bend specimens. These procedures have been submitted to several ASTM task groups, and it is hoped that these guidelines will be incorporated into current and future interlaboratory activities eventually leading to a standard method for testing. 3 tables, 5 figs.

37883 Approach to acoustic emission signal analysis: theory and experiment. Hsu, N.N. (Univ. of Kentucky, Lexington); Simmons, J.A.; Hardy, S.C. *Mater. Eval.;* **35**: No. 10, 100-106(Oct 1977).

The development of a theory is reported which allows the computation of the displacement as a function of time at an arbitrary point on an infinite plate due to an arbitrary point source force function. The theory is based on a new Fourier inversion technique which yields exact formulas similar to those developed for seismological "ray" theories. Experimental results are obtained on a 2.52-cm-thick aluminum plate using a reproducible step function stress release pulse as a simulated AE signal and a wide band displacement capacitive transducer as a sensor. The measurements are in quantitative agreement with the predictions of theory. Applications are discussed wherein the simulated signal, capacitive transducer and plate theory are used for AE source signature analysis and sensor calibration problems. 8 figs.

37884 Expediency of creating automated complexes for radiation defectoscopy. Akopov, V.S.; Voronin, S.A.; Meshalkin, I.A. *Vopr. Atom. Nauki i Tekhn. Radiats. Tekhn.;* No. 13, 297-304(1976). (In Russian).

The optimal productivity for automated radiation defectoscopy complexes produced up to 1990 will be 90,000 pictures per year. Methods must be developed to increase the sensitivity of radiation testing to 1.5% by 1990. Between 1973 and 1990, the volumes of testing of products by various methods of radiation defectoscopy will change, i.e., the volume of products tested by the radioscopic method will increase (from 6 to 24%), while the volume of products tested by the radiographic method will decrease (from 90 to 70%). It is desirable to use a small universal computer to interpret the results of radiation testing.

SAFETY ENGINEERING

37885 (IS-EMRRI—2(Rev.)) **Literature survey of dust explosions in grain handling facilities: causes and prevention.** Verkade, M.; Chiotti, P. (Iowa State Univ. of Science and Technology, Ames (USA). Energy and Mineral Resources Research Inst.). 1 Apr 1978. Contract W-7405-ENG-82. 127p. Dep. NTIS, PC A07/MF A01.

Concern over the recent toll in personal injuries and fatalities and the accompanying property and monetary losses suffered in grain industry dust explosions prompted the survey and study of the causes of the disasters and means of preventing or minimizing them. The circumstances and factors which contribute to a disatrous grain dust explosion are complex and far reaching. As a result, the study of dust explosions encompasses many factors including : (1) occurrences, causes and prevention, (2) dust collection methods, (3) safety training and education, (4) insurance standards, national codes and government regulations, (5) grain handling operations, (6) management principles, (7) economic aspects, (8) chemical and physical properties of dusts, (9) flame propagation mechanisms; (10) fire and explosion detection; and (11) explosion suppression and/or control. The literature search focused primarily on the period from 1955 to 1975. To provide perspective, older sources were also consulted, some of which dated back to the early twentieth century.

VACUUM ENGINEERING

37886 New highly effective adsorbent for sorption superhigh vacuum cryopumps. Maksimov, S.P.; Kravtsova, V.P.; Gashin, V.M.; Gur'yanov, V.V.; Shcherbakov, V.P.; Misin, M.S.; Sizova, G.P. *Vopr. At. Nauki i Tekhn. Ser. Fiz. i Tekhn. Vysokogo Vakuuma;* No. 1, 42-46(1976). (In Russian).

For the first time, a polymer material was used to develop a new high efficiency adsorbent—a cryosorbing carbon material (KUT) for superhigh vacuum sorption cryopumps. The adsorbent has a structure with a well-developed micropore volume and is characterized by high adsorption and physical-mechanical properties. In the process of development, the influence of structural parameters on the adsorption capacity for nitrogen at 77°K was studied in the range of equilibrium pressures of 10^{-5} to 760 mmHg. It is shown that the best experimental specimen has an adsorption capacity for nitrogen at $P < 1 \cdot 10^{-3}$ mmHg exceeding the adsorption capacity of commercial carbon type SKT-2 by more than an order of magnitude. The first experimental pilot batch of KUT-1 adsorbent for sorption superhigh vacuum cryopumps in experimental thermonuclear and other installations has been produced.

ELECTRONIC CIRCUITS AND DEVICES

REFER ALSO TO CITATION(S) 37174

37887 (GEPP—303A) **Effect of Mn/Ti surface treatment on voltage holdoff performance of alumina insulators in vacuum.** Miller, H.C.; Furno, E.J. (General Electric Co., St. Petersburg, Fla. (USA). Neutron Devices Dept.). 16 Mar 1978. Contract EY-76-C-04-0656. 17p. Dep. NTIS, PC A02/MF A01.

The treatment of the surface of an alumina insulator with a Mn/Ti coating significantly increases its voltage holdoff capability. Insulators treated with this coating had vacuum holdoff voltages about 25% higher than did untreated insulators. During processing (quasimetallizing) the coating penetrates into the alumina; thus, it is fairly insensitive to damage by abrasion or electrical breakdown. The quasimetallized coating is also compatible with subsequent metallizing and brazing of the alumina insulator. It is concluded that the coating decreases the surface resistivity of the insulator, decreases the secondary electron emission yield of the insulator and makes the surface of the insulator dielectrically more uniform.

37888 (Y/DA—7474) **Methods of calculating errors in precision rectifier circuits.** Duncan, M.G. (Oak Ridge Y-12 Plant, Tenn.

(USA)). 26 Sep 1977. Contract W-7405-ENG-26. 41p. (CONF-780518—1). Dep. NTIS, PC A03/MF A01.

From IEEE symposium on circuits and systems; New York, NY, USA (17 May 1978).

Diodes have been used for years as rectifiers, but due to forward voltage drop, accuracy is poor. Three methods of computing rectifier error based upon exponential models of the PN junction current-voltage characteristics are presented. An iterative hand analysis provides accurate prediction of rectifier performance at midband frequencies. To include frequency dependence, slewrate and other nonlinear characteristics, CSMP system models or nonlinear differential equation methods can be used.

37889 Gas injected vacuum switch. Hardin, K.D. (to Energy Research and Development Administration). US Patent 4,019,079. 19 Apr 1977. Filed date 7 May 1976. 4p.

PAT-APPL-684,420.

The disclosure relates to a gas injected vacuum switch comprising a housing having an interior chamber, a conduit for evacuating the interior chamber, within the chamber an anode and a cathode spaced from the anode, and a detonator for injecting electrically conductive gas into the chamber between the anode and the cathode to provide a current path therebetween.

WASTE PROCESSING PLANTS AND EQUIPMENT

REFER ALSO TO CITATION(S) 37594, 37596

COMBUSTION SYSTEMS

REFER ALSO TO CITATION(S) 37584, 37588, 37814

37890 Venting system for a gas-fired heating plant. Smith, D.L. (to Thrifty-Vent, Inc.). US Patent 4,079,727. 21 Mar 1978. Filed date 3 Dec 1976. 6p.

A venting system for the combustion chamber of a gas-fired heating plant has an elongate diverter box arranged vertically of the heating plant exteriorly thereof and having an upper portion and a lower portion with the latter having a bottom provided with a substantial opening disposed well above the base of the heating plant for the free admission of atmospheric air surrounding the heating plant into the diverter box. The upper portion has selected openings for the reception of horizontally disposed pipings from the flue outlet for the combustion chamber and for the chimney flue with a vertical baffle depending from the dlosed top of the upper portion a substantial vertical extent into the diverter box and dividing it into a flue outlet section and a chimney flue section. The sections have thermostat means to indicate the temperature of the gases. A safety limit switch is housed in the flue outlet section below the lower free end of the baffle and is protected by a barrier plate from cold down drafts from the chimney flue.

37891 Fluidised bed combustion for industrial boilers. *Build. Serv. Eng.;* **45**: No. 3, A23(Jun 1977).

Clarke Chapman Ltd have been operating an experimental fluidised bed combustor with a view to developing a range of industrial boilers with outputs of less than 30 MW.

37892 Burners put the brake on the big fuel burn-up. Wood, R. *Process Eng.;* 73-75(Apr 1977).

New developments in the design and operation of more efficient burners are discussed. (TFD)

37893 Electrical resistivity of a high-pressure fluidized bed. Lee, B.S.; Pyrcioch, E.J.; Schora, F.C. Jr. (Inst. of Gas Tech., Chicago). *Chem. Eng. Prog., Symp. Ser.;* **66**: No. 101, 75-80(1970).

Electrical resistivity in a fluidized bed of coal char is essentially constant with current density at ambient pressures, but decreases with increasing current density at high pressures. The postulated mechanism for current flow is through spark discharge between bed particles across gas gaps whose average magnitude is characterized by the bed expansion ratio.

UNDERGROUND ENGINEERING

37894 Tunnel driving technology. Moss, J.K. *Indian East. Eng.;* **119**: No. 5, 233-234(May 1977).

A brief survey of modern tunnel driving techniques is given. Companies that build the specialized machinery are discussed, and the bentonite shield method and borers for non-circular profiles are described. (PMA)

37895 Flameproof power packs for collieries. *Diesel Eng.;* **73**: No. 795, 196-198(Win 1977).

A diesel engine was incorporated in a flameproof power pack which has been approved by British, Canadian and German authorities for installation in underground vehicles and locomotives and as a general power source in coal mines. With power take-offs for the radiator fan, cooling water pumps, flameproofed alternator, and small hydraulic pump for priming the starter, the power pack develops a net brake output of 67.7 kW at 2500 rev/min with a peak torque of 314 Nm at 1500 rev/min. The power pack is offered in two basic configurations--Type A with in-line arrangement of engine, radiator and exhaust conditioner box having overall dimensions of 2300 mm x 900 mm x 1100 mm and Type B with the exhaust conditioner box alongside the engine for a squarer layout measuring 1900 mm x 1300 mm x 1100 mm overall.

MARINE ENGINEERING

37896 Arctic drilling base. Reusswig, G.H.; Bozeman, J.D.; Ray, D.R. (to Offshore Co.). US Patent 4,080,798. 28 Mar 1978. Filed date 18 Feb 1977. 12p.

An arctic drilling barge is disclosed to perform offshore activities in the shallow water, fast ice regions of the arctic seas. Optimal ice interaction is obtained by shaping the hull of the barge in the form of an upright frustum. Ice which does adhere to the barge is detached and melted by circulating fluid through a plurality of interior hull compartments next to the hull sidewalls of the barge.

37897 Pipe system for collecting petroleum from off-shore wells located at great depths. Behar, I.; Genini, M. (to Coflexip). US Patent 4,078,584. 14 Mar 1978. Filed date 19 Sep 1975. 4p.

A pipe system is described for collecting petroleum from offshore wells located at great depths that comprises flexible pipes connecting well head to a float comprising an at least partially submerged caisson which contains air so as to maintain the flexible pipes under tension. Rigid pipes within the caisson lead from the flexible pipes to a discharge opening in a superstructure which projects above the surface of the sea.

37898 Artificial islands in the Beaufort Sea. *Eng. J. (Montreal);* **60**: No. 4, 16-17(1977).

The Mackenzie Delta region, near the Yukon/NWT border, has potential oil and gas reserves that have attracted exploration drilling since the mid-1960s. Thirteen artificial islands, in water up to 28 feet in depth, were constructed as part of an offshore program. Two different construction techniques, the sandbag retention and the sacrificial beach methods, were employed for the artificial islands. In both cases the islands are intended only as temporary platforms for exploratory drilling, and thus have a limited life expectation, but they must protect men and equipment from summer storms and winter ice movement. The choice of island type depends mainly on availability of acceptable construction material and equipment, and on water depth.

POLLUTION CONTROL EQUIPMENT

REFER ALSO TO CITATION(S) 37253

37899 Process for the purification of flue and other waste gases. Hoelter, H.; Gresch, H.; Igelbuescher, H. US Patent 4,080,428. 21 Mar 1978. Priority date 19 Sep 1974, German, Federal Republic of (F.R. Germany). 10p.

The invention described is concerned with improved process and apparatus for the removal of sulfur dioxide from flue gas or other waste gas of the kind in which the waste gas is scrubbed by a circulating wash liquid containing lime suspensions, i.e. suspensions of calcium oxide, hydroxide or carbonate, the calcium/sulfur compounds so formed being oxidized and removed from the circulation, the improvements of the present invention comprising primarily the freeing of the wash liquid from solid matter before contact with the waste gas and then the control of pH values of the wash liquid at different stages of the circulation to facilitate, for example, the oxidation of the particular calcium/sulfur compound, formed in the scrubbing process, to calcium sulfate, the apparatus also being designed to improve the oxidation step.

37900 Method of desulfurizing exhaust gases by wet lime-gypsum process. Fujita, H.; Tao, K.; Tatani, A.; Kabumoto, T. (to Mitsubishi Jukogyo Kabushiki Kaisha). US Patent 4,080,427. 21 Mar 1978. Priority date 10 Sep 1975, Japan. 8p.

A method of desulfurizing exhaust gases by a wet lime-gypsum process comprises the steps of neutralizing a suitable amount of liquid containing impurities separating the neutralized material into solid and liquid phases, heating the separated solid phase to

dryness while concentrating the separated liquid phase, mixing the concentrated liquid and dried solid phase in such a manner that the resulting mixture exists as a solid mass containing the impurities, thus making it unnecessary to dispose of any waste liquid.

37901 Elimination of nitrogen oxides from exhaust gases with nitriles. Tanaka, T.; Yamamoto, T.; Takahashi, Y.; Obana, H.; Watanabe, K.; Wada, K.; Yamashita, K.; Ohki, K. (to Asahi Kasei Kogyo Kabushiki Kaisha). US Patent 4,080,425. 21 Mar 1978. Priority date 26 May 1975, Japan. 16p.

An exhaust gas containing nitrogen oxides is efficiently purified without the necessary use of catalysts by contacting the exhaust gas with a nitrile compound at high temperature in the presence of oxygen. The nitrogen oxides and the nitrile compound are selectively decomposed into harmless materials.

37902 Vapor condensing and recovery assembly including a decanter for vapor recovery system. Edwards, R.C. (to Edwards Engineering Corp.). US Patent 4,077,789. 7 Mar 1978. Filed date 2 Apr 1976. 24p.

A decanter for a system and apparatus for condensing and recovering vapors of low volatile liquids such as hydrocarbons has an inlet for the condensed vapors of the low volatile liquid, and an outlet for passing condensate from the decanter. A separating chamber in the decanter communicates with the inlet to receive condensate mixed with water, and a second chamber communicates with the outlet. A transfer device permits separated condensate to pass to the second chamber, and a heater is provided in the first chamber to maintain the water mixture above the freezing point thereof and preferably in a range from 40° to 70°F.

37903 Method for air pollution control combined with safe recovery and control of gases from a bottom-blown steel converter vessel. Baum, K.; Baum, J.P.; Pearce, J.K.; Schroeder, D.L. (to Pennsylvania Engineering Corp.). US Patent 3,998,626. 21 Dec 1976. Filed date 11 Mar 1975. 14p.

A gas collector hood is located close to the mouth of a converter vessel and has a diameter which is not much greater than the mouth of the vessel. A mixture of oxygen together with entrained powdered materials based on process requirements and a hydrocarbon fluid as cooling agent are blown through tuyers in the bottom of the vessel and diffuse through the hot metal in the vessel. The inherently finer dust produced from the bottom-blown oxygen process requires that for proper air pollution control a non-combustion system be used to take advantage of the increased agglomerating properties of iron oxides when produced in reducing atmospheres. When blowing is initiated in this process carbon monoxide and hydrogen evolve immediately and in order to render the gases inert, air is aspirated into the gas collector hood so that an inert gas plug is formed which purges the exhaust system of combustion air. A short time after blowing is initiated, the hood is brought down to proximity with the vessel in which case only a small percentage of the theoretically required air for combustion is aspirated. Nitrogen is injected as required into the hood in addition to air aspirated to artificially create inertization to turn down a heat at high carbon levels, for emergency vessel turn down, and for special heats. Near the end of a normal low carbon heat, air is again aspirated into the hood so that an inert gas plug is formed for safe turn down of the converter. Control of the system is achieved through high response sensors based on a gas analysis system independent of the components and products of combustion in the gas phase, operated together with automatic suction control incorporated as part of the gas cleaning system.

PARTICLE ACCELERATORS

DESIGN, DEVELOPMENT, AND OPERATION

37904 Some highlights of the University of Maryland Cyclotron program. Pugh, H.G. (Univ. of Maryland, College Park). pp 549-560 of Nuclear and particle physics at intermediate energies. Warren, J.B. (ed.). New York; Plenum Press (1976).

From Proceedings of the advanced study institute in nuclear and particle physics at intermediate energies; Victoria, B.C., Canada (Jun 1975).

See CONF-7506100—.

The operation of the Maryland Cyclotron, which has been running at full energy for three years, is reviewed. Beam energies obtained for various particles are given, and the layout of the cyclotron is described. Some of the experimental results obtained are briefly discussed. (PMA)

37905 Report of the status of the Indiana University Cyclotron Facility and preparations for initial experiments. Bent, R.D. pp 561-571 of Nuclear and particle physics at intermediate energies. Warren, J.B. (ed.). New York; Plenum Press (1976).

From Proceedings of the advanced study institute in nuclear and particle physics at intermediate energies; Victoria, B.C., Canada (Jun 1975).

See CONF-7506100—.

The IUCF accelerator consists of three stages. The preinjector and injector cyclotron were constructed in the main physics department building and operated there for the first time in May, 1972. Assembly of the main cyclotron began in December, 1971 soon after the new accelerator building became available for occupancy and continued in parallel with the reassembly and testing of the small cyclotron. A beam of 10 MeV protons was injected into the main cyclotron for the first time on June 13, 1975. The present goal is to achieve acceleration in the main cyclotron and extraction during the summer and beam on target in September, 1975. This will allow the first experiments to begin in the late fall of 1975. The first round of proposals was evaluated by the IUCF Program Advisory Committee in February, 1975. The total request for beam time was 680 eight-hour shifts. 200 eight-hour shifts were approved for the first 6-month running period. A list of the approved proposals is given.

BEAM DYNAMICS, FIELD CALCULATIONS, AND ION OPTICS

37906 (TID—28278) **Further parametric studies of the accelerator system for heavy ion fusion.** Teng, L.C. (Fermi National Accelerator Lab., Batavia, Ill. (USA)). 12 Sep 1977. Contract EY-76-C-02-3000. 16p. Dep. NTIS, PC A02/MF A01.

In earlier studies we made the seemingly obvious assumption that the heaviest ion with the lowest charge state is most desirable. A closer examination showed that this is not entirely true. Furthermore, little attention was paid to the beam transport lines from the accelerator(s) to the reactor vessel. Simple calculations would reveal that the requirements of the bending dipoles in these transport lines and the final quadrupoles for focusing the beams onto the target are rather unrealistic for the examples given. All these are re-examined in this paper.

AUXILIARIES AND COMPONENTS

EXPERIMENTAL FACILITIES AND EQUIPMENT

REFER ALSO TO CITATION(S) 38532

37907 Omicron spectrometer. Allardyce, B.W. (CERN, Geneva). pp 369-382 of Nuclear and particle physics at intermediate energies. Warren, J.B. (ed.). New York; Plenum Press (1976).

From Proceedings of the advanced study institute in nuclear and particle physics at intermediate energies; Victoria, B.C., Canada (Jun 1975).

See CONF-7506100—.

Technical features and experiment possibilities are discussed for the planned large solid angle spectrometer, Omicron, for the CERN Synchrocyclotron. The spectrometer will have a large momentum acceptance and an energy resolution of about 1 MeV for up to 400 MeV/c. Technical features include the magnet, location, detectors, magnet box, and the on-line measurement system. Scattering, charge exchange, and branching ratio experiments are proposed. (PMA)

37908 Status report on the SIN Universal Spectrometer Installation (SUSI). Boschitz, E.T. (Univ., Karlsruhe, Ger.). pp 383-391 of Nuclear and particle physics at intermediate energies. Warren, J.B. (ed.). New York; Plenum Press (1976).

From Proceedings of the advanced study institute in nuclear and particle physics at intermediate energies; Victoria, B.C., Canada (Jun 1975).

See CONF-7506100—.

A discussion is given of the planned pion-channel and pion-spectrometer for nuclear structure studies at the SIN Cyclotron. Topics covered include experiment planning, beam optics, magnet design, and beam transport. (PMA)

37909 Proton physics at SIN. Greeniaus, L.G. (Univ., Geneva). pp 591-601 of Nuclear and particle physics at intermediate energies. Warren, J.B. (ed.). New York; Plenum Press (1976).

From Proceedings of the advanced study institute in nuclear and particle physics at intermediate energies; Victoria, B.C., Canada (Jun 1975).

See CONF-7506100—.

A brief discussion is given of accelerator facilities and experiment planning at the SIN Cyclotron. Pion beams for nuclear and

biomedical research, muon beams, neutron beams and polarized proton beams are available. The planned program for the next five years includes considerable effort in the nucleon-nucleon field. (PMA)

STORAGE RINGS

37910 (BNL—24207) **Proton storage rings.** Rau, R.R. (Brookhaven National Lab., Upton, N.Y. (USA)). Apr 1978. Contract EY-76-C-02-0016. 21p. Dep. NTIS, PC A02/MF A01.

A discussion is given of proton storage ring beam dynamic characteristics. Topics considered include: (1) beam energy; (2) beam luminosity; (3) limits on beam current; (4) beam site; (5) crossing angle; (6) beam—beam interaction; (7) longitudinal instability; (8) effects of scattering processes; (9) beam production; and (10) high magnetic fields. Much of the discussion is related to the design parameters of ISABELLE, a 400 x 400 GeV proton—proton intersecting storage accelerator to be built at Brookhaven National Laboratory. (PMA)

37911 **Equilibrium phase-locked states in a relativistic electron beam in a storage ring.** Naugol'nyi, N.N. *Sov. Phys. - Tech. Phys. (Engl. Transl.);* **22**: No. 7, 870-873(Jul 1977).

The possibility of phase locking of a relativistic beam of charged particles in a storage ring is studied for the case in which the beam interacts with passive external structures. Steady-state soliton solutions are found and their stability is analyzed. In particular, above the critical energy passive inductive elements in the chamber provide nonlinear saturation for the soliton amplitude, regardless of the focusing force.

INSTRUMENTATION

RADIATION INSTRUMENTATION

GENERAL DETECTORS AND MONITORS

REFER ALSO TO CITATION(S) 37301

37912 (IAEA-SM—222/06) **Radiation protection instrumentation test and calibration.** Selby, J.M.; Larson, H.V.; Bartlett, W.T.; Mulhern, O.R.; Fleming, D.M. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1977. Contract EY-76-C-06-1830. 7p. (CONF-771209—12). Dep. NTIS, PC A02/MF A01.

From IAEA symposium on national and international standardization of radiation dosimetry; Atlanta, GA, USA (5 Dec 1977).

The operational requirements of radiation protection instrumentation are set forth in the recommendations of various commissions and committees. Additionally, the user may establish the need for different or more restrictive requirements. The ability to meet these requirements will depend not only on the instrument capabilities but also on periodic recalibrations, preventative maintenance, and testing of the instruments. A new standard, ANSI N323, "Radiation Protection Instrumentation Test and Calibration," has been prepared and approved for use. This standard establishes calibration methods for portable radition protection instruments used for detection and measurement of levels of ionizing radiation fields or levels of radioactive surface contamination. Included within the scope of this standard are conditions, equipment and techniques for calibration as well as the degree of precision and accuracy required. The salient points of the new standard are presented. The nature of improvements required by the standard are discussed.

37913 (ORNL/Sub—7200/4) **Research in radiation monitoring survey instrumentation. Final report.** Blalock, T.V.; Kennedy, E.J.; Phillips, R.G.; Walker, E.W. Jr. (Tennessee Univ., Knoxville (USA). Dept. of Electrical Engineering). 20 Jan 1978. Contract W-7405-ENG-26. 64p. (TR-EE/EL—9). Dep. NTIS, PC A04/MF A01.

Two low-power solid-state prototype readout units were developed, an LED display and a LCD display. This display output was in a bar-graph format, covering four-decades of information, with 10-segments per decade. The displays accept a frequency input, which is standardly available from several portable radiation-survey instruments. Both readout units will operate on two D-cell batteries (3.0 Volt), with a typical current drain requirement of 0.3 MA for the LED display and 30μA for the LCD display. A wide-range electrometer circuit was also developed. The circuit covers an input current range from 10^{-13} A to 10^{-6} A. The output signal is a pulse whose frequency is directly proportional to input current. The circuit requires no high-megohm resistors, and is autoranging. Several candidate input amplifiers were analyzed and evaluated for use with the electrometer circuit.

37914 (UCID—17721) **Operating manual for the de Phanger precision long counter (PLC).** Slaughter, D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 6 Feb 1978. Contract W-7405-ENG-48. 13p. Dep. NTIS, PC A02/MF A01.

The setting up, calibration operation, characteristics, and problems of the precision long counter for neutron intensity measurements are discussed. (WHK)

37915 **Two-dimensional x-ray detector array.** Houston, J.M. (to General Electric Co.). US Patent 4,047,039. 6 Sep 1977. Filed date 3 Jun 1976. 8p.

A two-dimensional array of ionization chamber x-ray detector cells comprises a plurality of planar anode assemblies disposed equidistant between parallel cathode plates in a gas of high atomic number. Each anode assembly comprises a plurality of conductive strips disposed on a thin dielectric sheet in a direction substantially parallel to the incident x-ray energy.

37916 **Gridded ionization chamber.** Houston, J.M. (to General Electric Co.). US Patent 4,047,040. 6 Sep 1977. Filed date 6 May 1976. 6p.

An improved ionization chamber type x-ray detector comprises a heavy gas at high pressure disposed between an anode and a cathode. An open grid structure is disposed adjacent the anode and is maintained at a voltsge intermediate between the cathode and anode potentials. The electric field which is produced by positive ions drifting toward the cathode is thus shielded from the anode. Current measuring circuits connected to the anode are, therefore, responsive only to electron current flow within the chamber and the recovery time of the chamber is shortened. The grid structure also serves to shield the anode from electrical currents which might otherwise be induced by mechanical vibrations in the ionization chamber structure.

37917 **X-ray detector array.** Houston, J.M. (to General Electric Co.). US Patent 4,047,041. 6 Sep 1977. Filed date 19 Apr 1976. 8p.

An ionization chamber array, useful in computerized x-ray tomography apparatus comprises a plurality of substantially parallel, rod-like cathodes disposed equidistant between parallel planar anodes in a high pressure detector gas. X-ray energy enters the array in the plane of the cathodes in a direction substantially parallel to their long dimensions.

37918 **Gamma ray camera for nuclear medicine.** Schlosser, P.A.; Steidley, J.W. (to Ohio State Univ.). US Patent 4,047,037. 6 Sep 1977. Filed date 9 Feb 1976. 20p.

An improved gamma camera arrangement is described wherein the spatially defined acceptance of gamma radiation from a source distribution of clinical interest is enhanced by a unique collimator structure. Aliasing frequencies otherwise derived from an orthogonal strip detector array are identified and avoided through a structural geometry wherein collimator resolution is greater than or equal to about 1.7(l), where, l, is the strip spacing of the array.

37919 **Automatic system for continuously calibrating a gamma camera.** Auphan, M.J. (to U.S. Philips Corp.). US Patent 4,047,034. 6 Sep 1977. Priority date 27 Sep 1974, France. 6p.

A circuit is described for continuously recalibrating a gamma camera having a plurality of photomultipliers and signal channels which are weighted to control X and Y deflection on the display. Variation in signal channel gain is controlled and cancelled.

RADIATION DOSEMETERS

REFER ALSO TO CITATION(S) 37912

37920 (IAEA-SM—222/08) **Technique to compensate for geometry-induced errors in a photon irradiator calibration.** Mulhern, O.R.; Hooker, C.D. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1977. Contract EY-76-C-06-1830. 8p. (CONF-771209—10). Dep. NTIS, PC A02/MF A01.

From IAEA symposium on national and international standardization of radiation dosimetry; Atlanta, GA, USA (5 Dec 1977).

The calibration of the exposure rate instrumentation used at Hanford necessitates the exposure of the instruments to photon beams at various radiation intensities. To simulate the wide variety of photon energies encountered, half a gram of ^{226}Ra + daughters is used. So that a minimum exposure to calibrations personnel is assured, the source is contained in an open-toped concrete well about 8 m deep. Instruments to be calibrated are placed in a holder at the top of the well and the source is raised to the prescribed position which gives the desired exposure rate. The primary calibration of the well poses unique problems because the exposure rates vary from place to place across the top surface of the well. Therefore, a transfer standard, being of a different volume and shape from the instruments being calibrated, responds differently to a source position than does a service instrument. To compensate for this variation, a service instrument has been modified to accommodate an

integration device and a digital readout. The instrument is first calibrated, free-in-air, by comparison to the transfer standard, and is then placed over the well in exactly the same position at which all instruments of that type are calibrated. The exposure rate is integrated over a sufficiently long time to eliminate the measurement errors resulting from a rate-only readout. The calibration accuracy is discussed and an analysis of the error contributions at each step is provided.

NUCLEAR SPECTROSCOPIC INSTRUMENTATION

REFER ALSO TO CITATION(S) 37018

HIGH ENERGY PHYSICS INSTRUMENTATION

REFER ALSO TO CITATION(S) 37907, 37908

37921 Track chambers with semiconductor detectors. Eremin, V.K.; Verbitskaya, E.M.; Strokan, N.B.; Tisnek, N.I. (A. F. Ioffe Physicotechnical Institute, Academy of Sciences of the USSR, Leningrad). *Sov. Tech. Phys. Lett. (Engl. Transl.);* **3**: No. 9, 348-349(Sep 1977).

The use of two electronic circuits operating simultaneously is suggested in the design of a particle spectrometer.

37922 Current level detector. Kerns, C.R. (to Energy Research and Development Administration). US Patent 4,027,239. 31 May 1977. Filed date 25 Nov 1975. 6p.

PAT-APPL-635,016.

A device is provided for detecting the current level of a dc signal. It includes an even harmonic modulator to which a reference ac signal is applied. The unknown dc signal acts on the reference ac signal so that the output of the modulator includes an even harmonic whose amplitude is proportional to the unknown dc current. The device may be used to provide overcurrent protection for proportional wire chambers.

RADIOMETRIC INSTRUMENTS

REFER ALSO TO CITATION(S) 37934

37923 Strip profile measurement. Smith, K.B.; Adams, D.W. (to Heath (Gloucester) Ltd.). US Patent 4,047,036. 6 Sep 1977. Priority date 10 May 1975, United Kingdom of Great Britain and Northern Ireland (UK). 10p.

A radiation gauge for measuring the profile of a moving strip, e.g., strip issuing from a strip rolling mill, comprises two x-ray tubes arranged on one side of the strip. The x-ray tubes are connected in push-pull configuration, for pulsing in alternation, and they each produce a respective curtain of radiation which intersects the strip in a respective straight line extending across the width of the strip, perpendicular to its direction of travel: these two straight lines are aligned with each other and overlap slightly in the center of the strip. A linear array of radiation detectors is disposed on the other side of the strip, so as to receive the radiation which passes through the strip. Signal processing circuitry processes the detector output signals to display the deviation of the thickness profile of the strip from a predetermined thickness profile.

37924 Self-compensating x-ray or γ-ray thickness gauge. Allport, J.J. US Patent 4,047,029. 6 Sep 1977. Filed date 2 Jul 1976. 12p.

A gauge is described for determining the mass per unit area, or alternatively the thickness of sheet material by measuring the attenuation, as well as backscatter, of an x-ray beam or the like, while continuously taking into account deviations and changes in localized material composition, insofar as these have an effect on the transmission coefficient of the beam. Electrical signals representing these deviations are combined with calibration data for given material nominal properties, i.e., nominal composition. The resultant and output signal represents the mass per unit area or thickness.

37925 Ionization smoke sensor. Minowa, O. (to Hochiki Corp.). US Patent 4,044,262. 23 Aug 1977. Priority date 10 Feb 1975, Japan. 4p.

An ionization smoke sensor is described wherein the electric circuit of the sensor is surrounded by a first metallic case. An ionization chamber into which smoke from the exterior enters is constructed of a radiation source, an intermediate electrode and an outer electrode; the outer electrode is formed of a second metallic case; and the first and second metallic cases are electrically connected through a member of conductive elastomer, so that electric elements of the electric circuit are protected from external electrostatic charges.

37926 Ionization dual-zone static detector having single radioactive source. Ried, L. Jr.; Wade, A.L. (to Walter Kidde and Co., Inc.). US Patent 4,044,263. 23 Aug 1977. Filed date 28 Jan 1975. 12p.

This ionization detector or combustion product detector includes a single radioactive source located in an ionization chamber, and the ionization chamber includes portions comprising a reference zone and a signal zone. Electrical circuitry connected to the reference and signal zones provides an output signal directly related to changes in voltages across the signal zone in relation to the amount of particulates of combustion present in the ionization chamber.

37927 Ionization detection system for aerosols. Jacobs, M.E. (to Energy Research and Development Administration). US Patent 4,027,165. 31 May 1977. Filed date 17 Feb 1976. 6p.

PAT-APPL-658,807.

This invention relates to an improved smoke-detection system of the ionization-chamber type. In the preferred embodiment, the system utilizes a conventional detector head comprising a measuring ionization chamber, a reference ionization chamber, and a normally non-conductive gas triode for discharging when a threshold concentration of airborne particulates is present in the measuring chamber. The improved system utilizes a measuring ionization chamber which is modified to minimize false alarms and reductions in sensitivity resulting from changes in ambient temperature. In the preferred form of the modification, an annular radiation shield is mounted about the usual radiation source provided to effect ionization in the measuring chamber. The shield is supported by a bimetallic strip which flexes in response to changes in ambient temperature, moving the shield relative to the source so as to vary the radiative area of the source in a manner offsetting temperature-induced variations in the sensitivity of the chamber. 8 claims, 7 figures.

MISCELLANEOUS INSTRUMENTS

REFER ALSO TO CITATION(S) 36653, 36676, 36818, 36827, 37459, 38017, 38044, 38053, 38054, 38064, 38072, 38105, 38106, 38107, 38116, 38256

37928 (CONF-7510172—P1, pp 293-304) **Correlation interferometer: a new instrument specifically designed for remote measurement of atmospheric trace species.** Dick, R. (Barringer Research Ltd., Toronto); Barringer, A.R.; Levy, G.M.; Zwick, H.; Goldstein, H.W.; Grenda, R.N.; Bortner, M.H.; LeBel, P.J. 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

By making full use of the known properties of the possible variety of measurement situations, the data rate of a remote sensor may be minimized and its selectivity maximized. An example is given of a specialized instrument designed in this manner for remote sensing of carbon monoxide and other trace species. Some test results are included.

37929 Device for measuring local radiation absorption in a body. Wagner, W. (to Philips Corp.). US Patent 4,057,725. 8 Nov 1977. Priority date 6 Sep 1974, German, Federal Republic of (F.R. Germany). 4p.

A device for measuring the spatial distribution of radiation absorption in a body is described wherein a multiplicity of radiators are regularly distributed about a circle surrounding the body, each radiator emitting a wedge-shaped beam of radiation in the plane of the circle toward a different arc portion of the circle between two other radiators, a multiplicity of adjoining detectors in each arc portion measuring radiation from the radiator emitting radiation to that arc portion, the spatial distribution of radiation absorption being calculated from the measured radiation values of all the detectors.

37930 Dynamic multistation photometer. Bauer, M.L.; Johnson, W.F.; Lakomy, D.G. (to Energy Research and Development Administration). US Patent 4,030,834. 21 Jun 1977. Filed date 8 Apr 1976. 6p.

PAT-APPL-675,085.

A portable fast analyzer is provided that uses a magnetic clutch/brake to rapidly accelerate the analyzer rotor, and employs a microprocessor for automatic analyzer operation. The rotor is held stationary while the drive motor is run up to speed. When it is desired to mix the sample(s) and reagent(s), the brake is deenergized and the clutch is energized wherein the rotor is very rapidly accelerated to the running speed. The parallel path rotor that is used allows the samples and reagents to be mixed the moment they are spun out into the rotor cuvetes and data acquisition begins immediately. The analyzer will thus have special utility for fast reactions.

37931 Multiple-image oscilloscope camera. Yasillo, N.J. (to Department of Energy). US Patent Application 763,166. 27 Jan 1977. 8p.

An optical device for placing automatically a plurality of images at selected locations on one film comprises a stepping motor

coupled to a rotating mirror and lens. A mechanical connection from the mirror controls an electronic logical system to allow rotation of the mirror to place a focused image at the desired preselected location. The device is of especial utility when used to place four images on a single film to record oscilloscope views obtained in gamma radiography.

37932 High-resolution radiography by means of a hodoscope. De Volpi, A. (to Department of Energy). US Patent Application 763,436. 27 Jan 1977. 8p.

The fast neutron hodoscope, a device that produces neutron radiographs with coarse space resolution in a short time, is modifed to produce neutron or gamma radiographs of relatively thick samples and with high space resolution. The modification comprises motorizing a neutron and gamma collimator to permit a controlled scanning pattern, simultaneous collection of data in a number of hodoscope channels over a period of time, and computerized image reconstruction of the data thus gathered.

37933 Using color tv simultaneously to display x-ray maps of three elements. Pawley, J.B.; Hayes, T.L. (Univ. of California, Berkeley). *Proc. Microsc. Soc. Can.;* **3**: 50-51(1976).

X-ray maps show the spatial distribution of a selected element on the surface of a sample being scanned in an electron beam instrument. Composite maps showing the spatial distribution of several elements can be made by coding each map with a different color and combining them all on a color recording medium. The correlation and interpretation of elemental distributions are facilitated by such multielement maps. The system described utilizes a standard Red, Green, Blue (RGB) color TV monitor as the display. (WHK)

WELL LOGGING INSTRUMENTATION

REFER ALSO TO CITATION(S) 37174

37934 Dual spectra well logging system and method. Pitts, R.W. Jr.; Whatley, H.A. Jr. (to Texaco Inc.). US Patent 4,042,824. 16 Aug 1977. Filed date 22 Dec 1975. 10p.

PAT-APPL-643,261.

A well logging system and method are described in which a transmitter in a borehole has at least two radiation detectors sensing either the same condition or two different conditions relating to the earth's formation traversed by the borehole and providing pulse signals having reference pulses and data pulses corresponding in number and peak amplitude to the sensed condition. Each pulse signal is sampled at different times by a sampling circuit which provides pulses of opposite polarity whose amplitudes correspond to the amplitudes of the first pulses occurring during sampling periods. The pulses from the sampling circuit are conducted to surface electronics by a single conductive path such as the inner conductor and the shield of an armored coaxial cable. The surface electronics include a pulse separation circuit which separates the pulses polarity. Processing circuits process the separated pulses to provide records of at least two spectra. 15 claims, 3 figures.

EXPLOSIONS AND EXPLOSIVES

CHEMICAL

REFER ALSO TO CITATION(S) 36627, 37938, 38330

37935 (LA—7158) **High-temperature shock initiation of explosives.** Ramsay, J.B.; Craig, B.G.; Dick, J.J. (Los Alamos Scientific Lab., N.Mex. (USA)). Mar 1978. Contract W-7405-ENG-36. 20p. Dep. NTIS, PC A02/MF A01.

The detonation sensitivity to plane shockwave loading of three polycrystalline, high-density explosives (PBX-9501, DATB, and TNT) was measured for runs-to-detonation up to 2.5 cm in the temperature range 25 to 150°C. Streak camera recording was used to obtain the shock-wave propagation distance, the initial shock velocity in the explosive, and the free-surface velocity of the driver. For PBX-9501 and DATB no significant change in distance-to-detonation was detected between 25 and 100°C, whereas a decrease in the distance-to-detonation of approximately 30% for the same input pressure was noted for shots fired at 150°. A small decrease in distance-to-detonation was noted for cast TNT between 25 and 73°. The time-to-detonation for liquid TNT at 150° for an input shock strength of 13 GPa was measured. Possible mechanisms leading to increased sensitivity in polycrystalline explosives at high temperature are discussed. However, the nonmonotonic nature of the relationship between pressure and distance-to-detonation as a function of temperature indicates that a simple thermal model is not adequate.

37936 (LA—7193-MS) **Detonation sensitivity tests.** Urizar, M.J.; Peterson, S.W.; Smith, L.C. (Los Alamos Scientific Lab., N.Mex. (USA)). Apr 1978. Contract W-7405-ENG-36. 42p. Dep. NTIS, PC A03/MF A01.

Four detonation sensitivity tests are described, and the results obtained in applying the tests to a variety of high explosives are presented. In the analysis of the data, emphasis is placed on an examination of the extent to which the tests correlate, one with another. It is concluded that the correlation is generally good, but that exceptions are numerous enough that no one test can be used with confidence as a measure of the detonation sensitivity of an explosive over a range of conditions of practical interest.

NUCLEAR

REFER ALSO TO CITATION(S) 38326

37937 (UCID—17619) **Measured air overpressures, soil-particle pressures, and slumps during the pre-ASIAGO U2Ar stemming experiment.** Freynik, H.S. Jr.; Roach, D.R.; Dittbenner, G.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 4 Jan 1978. Contract W-7405-ENG-48. 75p. Dep. NTIS, PC A04/MF A01.

On November 15, 1976, Lawrence Livermore Laboratory completed its first comprehensive stemming experiment for measuring downhole parameters while varying fill material and rate. Stemming can be defined as backfilling a hole in which a device has been placed to prevent leakage of radioactive materials or gases to the surface. A computer code is being developed for stemming operations, and this experiment was designed to measure parameters under different stemming conditions so the code could be verified and modified. The experiment was conducted in the lower half of a steel-cased, 4-ft-diam, 2000-ft-deep hole at Nevada Test Site. The two stemming materials used in the experiment, Overton sand and LLL II mix, were tested at three fill rates. Significant results of this experiment included successful measurement of downhole air overpressures, vertical and horizontal soil-particle pressures, and temperature. Vertical soil-particle pressures were higher than expected. All surface measurements were valid. The slump-displacement measurements system provided a timing mark to indicate the occurrence of a slump. A major slump occurred on the third day of stemming; a minor slump occurred on the fourth day.

WEAPONRY

37938 (UCRL—52396) **Nuclear explosives program: a proposal for high explosives research and development and a supporting facility.** Weingart, R.C.; Cochran, S.G.; Finger, M.; Goosman, D.R.; Guarienti, R.P.; Lee, E.L.; Lee. R.S.; Lyle, J.W.; Ravenscroft, D.S.; Stroud, J.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Nov 1977. Contract W-7405-ENG-48. 21p. Dep. NTIS, PC A02/MF A01.

Our long-range plan for high explosives (HE) research and deveolopment will significantly impact the nuclear weapons program at Lawrence Livermore Laboratory. This plan covers many aspects of explosive technology: the development of new high-energy and insensitive explosives, a more precise characterization of explosive materials, and a clearer understanding of the mechanisms of both deliberate and accidental HE initiation. At the core of this plan is a new research and development facility dedicated to accomplishing the tasks that mark technological progress. When it is complete, this facility will provide a capability at LLL for HE studies unmatched in the free world; it will greatly expedite HE work that is crucial to the nation's nuclear weapons program. The proposed plan will produce a level of technology that will permit the design of nuclear weapons with a great measure of HE safety. For the first time, HE response of nuclear weapons to accidental stimuli can be predicted and modeled. The plan will also lead to major improvements in HE implosion systems, so that significant savings in fissile materials and weapon size can be realized.

37939 (USGS—712-D) **Hydrologic processes and radionuclide distribution in a cavity and chimney produced by the Cannikin nuclear explosion, Amchitka Island, Alaska.** Claassen, H.C. (Geological Survey, Washington, D.C. (USA)). 1978. 44p. Dep. NTIS, PC A03/MF A01.

An analysis of hydraulic, chemical, and radiochemical data obtained in the vicinity of the site of a nuclear explosion (codenamed Cannikin, 1971), on Amchitka Island, Alaska, was undertaken to describe the hydrologic processes associated with the saturation of subsurface void space produced by the explosion. Immediately after detonation of the explosive, a subsurface cavity was created surrounding the explosion point. This cavity soon was partly filled

by collapse of overburden, producing void volume in a rubble chimney extending to land surface and forming a surface-collapse sink. Surface and groundwater immediately began filling the chimney but was excluded for a time from the cavity by the presence of steam. When the steam condensed, the accumulated water in the chimney flowed into the cavity region, picking up and depositing radioactive materials along its path. Refilling of the chimney voids then resumed and was nearly complete about 260 days after the explosion. The hydraulic properties of identified aquifers intersecting the chimney were used with estimates of surface-water inflow, chimney dimensions, and the measured water-level rise in the chimney to estimate the distribution of explosion-created porosity in the chimney, which ranged from about 10 percent near the bottom to 4 percent near the top. Chemical and radiochemical analyses of water from the cavity resulted in identification of three aqueous phases: groundwater, surface water, and condensed steam. Although most water samples represented mixtures of these phases, they contained radioactivity representative of all radioactivity produced by the explosion.

ENVIRONMENTAL SCIENCES, ATMOSPHERIC

BASIC STUDIES

REFER ALSO TO CITATION(S) 37993, 38014

37940 (CONF-7510172—P1, pp 319-325) **Formation of reflection spectrum of the earth near the boundary dividing two uniform surfaces.** Buznikov, A.A.; Kondratev, K.Ya.; Smokty, O.I. (Univ. of Leningrad). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

One of the main directions of modern space investigations consists in a study of reflection spectra of the earth as a planet using special optical apparatus installed on manned spacecraft and orbital stations. Of great interest for the aerospace survey of natural formations are spectrophotometric measurements of the underlying surface formed by two extensive uniform semiplanes with different optical properties. An analysis of reflection spectra formed near the interface of two uniform media permits the investigation of the frequency-contrasting characteristics of the atmosphere and of its transfer function for the brightnesses and contrasts of natural formations on the earth's surface. Very important for an analysis of the data of the aerospace photography and spectrophotometric measurements is a clear-cut fixation of the object-background interface and the determination of linear dimensions of the region of optical non-uniformity for each wavelength. In the current paper this problem is solved for the example of analysis of the data obtained from the manned spacecraft "Soyuz-9" during spectrophotometric measurements of the sand seashore—water surface interface near the cape Bekdash, the Caspian Sea.

37941 (CONF-7510172—P1, pp 327-332) **Solar occultation measurements of the water vapor mixing ratio in the stratosphere and mesosphere from the Salyut-4 orbital station.** Kondratev, K.Ya.; Buznikov, A.A.; Grechko, G.M.; Gubarev, A.A.; Pokrovsky, A.G. (Univ. of Leningrad). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

The results of solar occultation measurements of the water vapor mixing ratio in the stratosphere and mesosphere performed in January, 1975 over Marshall Islands with the spectrometer installed on the "Salyut-4" orbital station are discussed. The solar occultation measurements were performed at sunrise. An IR spectrometer with the channel range of 3800 to 3825 cm^{-1} and spectral resolution of 0.8 cm^{-1} was used. The results obtained revealed the presence of a "dry" stratosphere with the mixing ratio of about 10^{-6} over Marshall Islands at the time of the experiment.

37942 (CONF-7510172—P1, pp 333-335) **Optical method for determination of CO_2 total abundance in a vertical column of the atmosphere.** Brounshtein, A.M.; Frolov, A.D.; Shashkov, A.A. (Hydrometeorological Service of the USSR, Leningrad). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

Despite the relatively small CO_2 concentration in the earth's atmosphere (about 330 ppM—millionth parts by volume), the gas is an important climate-forming factor. The estimation of CO_2 influence on the Earth's climate was made using comparatively crude numerical models, however they show the importance of controlling the CO_2 concentration averaged over height (or the total CO_2 content in the atmospheric vertical column) with the aim of detecting concentration changes with time (the trend). The trend being small (0.5 to 1.2 ppM per year), highly accurate measurements are required. At present the magnitude of CO_2 trend is determined from local ground-level concentration measurements having been carried out at US baseline stations for a number of years. However considerable difficulties arise in selecting the site of a baseline station and observation conditions if one wants to use these data as mean over height CO_2 concentration because of the necessity to avoid the influence of local CO_2 sources. The method for determination of the total CO_2 abundance from solar radiation absorption spectra developed in the Main Geophysical Observatory (Leningrad, USSR) is based on using the ratio R of transmittances in the neighboring spectral intervals of the $4\nu_2 + \nu_3$ (2.06 mkm) CO_2 Band as a characteristic of the absorbing gas amount over the radiation path. Optimal photo-metering conditions for the usual optical paths in the atmosphere are provided in the selected band. Besides the band is comparatively clear, being overlapped only by weak water vapor lines.

37943 (CONF-7510172—P1, pp 533-543) **Development of remote sensing techniques in Italy.** Cassinis, R. (Univ. of Milan). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

This presentation is a short overview of the present activity in the field of remote sensing in Italy and of its development since 1970, when a small research group of the National Research Council introduced into our country the techniques of remote sensing. The ERTS-1 experiment (Landsat 1) played a very important role of promotion also considering that the Italian region is generally favored by good meteorological conditions. Following the successful Landsat 1, the launch of Landsat 2 and the completion of a ground receiving station (TERRA Project) seem to be favorable elements to a further increase of the activity both in research and application. Some examples of integrated surveys show that, though an official coordinating Agency is not yet operating, a remote sensing community does already exist in Italy.

37944 (CONF-7510172—P1, pp 571-582) **Heat capacity mapping: is it feasible.** Rosema, A. (NIWARS, Delft, Netherlands). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

This paper treats several stages of thermal modeling, in an attempt to discover its essential components, to assay the present conception of thermal inertia mapping, and to indicate a probably satisfying approach.

37945 **Method to measure drift deposition from saline natural draft cooling towers.** Israel, G.W. (Technische Univ., Berlin); Overcamp, T.J.; Pringle, W.J. *Atmos. Environ.;* **11**: No. 2, 123-130(1977).

The paper describes an automated drift sampler which collects drift with an efficiency of (94 +- 3)% and a precision (1 S.D.) of 13% from saline water cooling towers. Sampler calibrations and drift deposition measurements were conducted in the vicinity of a brackish-water natural-draft cooling tower. The drift deposition measurements are compared with drift deposition rates predicted from model calculations. Preliminary results show that measurements and model predictions exhibit the same trend in changes of drift size and deposition rate with increasing distance from the tower. With one exception the preliminary model over-estimates, however, the total deposition rates by a factor of two to ten. The experiments show that the samplers are suitable for collecting field data appropriate for testing and verification of drift dispersion models.

37946 (UCRL—52366) **Development of a three-dimensional model of the atmospheric boundary layer using the finite element method.** Lee, R.L.; Gresho, P.M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 22 Nov 1977. Contract W-7405-ENG-48. 24p. Dep. NTIS, PC A02/MF A01.

This report summarizes our current effort and ideas toward the development of a model for the planetary boundary layer using the finite element technique. As an initial step, the finite element methodology is applied to simpler version of the boundary layer equations given by the two-dimensional, constant-property, incompressible conservation equations (Navier-Stokes equations). Solution procedures for both the steady-state and transient equations are

discussed. For the transient problem, a variable time-step, trapezoid-rule algorithm with dynamic time-truncation error control is presented. The resulting system of nonlinear algebraic equations is solved by a Newton iteration procedure with a frontal solution scheme used for the linear set of equations. The need to develop a suitable linear equation solver, with respect to minimization of computer storage and execution costs, particularly for large (three-dimensional) finite element problems, is also discussed.

37947 High-frequency temperature and humidity correlation above a warm wet surface. Wesely, M.L.; Hicks, B.B. (Radiological and Environmental Research Division, Argonne National Laboratory, Argonne, Ill. 60439). *J. Appl. Meteorol.;* **17**: No. 2, 123-128(Feb 1978).

Temperature and humidity fluctuations at frequencies within the inertial subrange are found experimentally to be partially correlated in the surface boundary layer over warm wet surfaces. The spectral correlation coefficient, deduced from variances and covariances computed by analog electronics, is near unity in the flux-carrying eddies and decreases with increasing frequency, approximately as n/sup -1/2/. As a result, optical refractive index fluctuations may have the false appearance of being strongly anisotropic in the inertial subrange.

37948 Comparison of diffusion from a small island and an undisturbed ocean site. Raynor, G.S.; Brown, R.M.; SethuRaman, S. (Brookhaven National Laboratory, Upton, N. Y. 11973). *J. Appl. Meteorol.;* **17**: No. 2, 129-139(Feb 1978).

Experiments were conducted to investigate the differences in diffusion from an obstacle to free air flow in the ocean and from an undisturbed ocean site. A small island was used as the obstacle and simultaneous releases of oil-fog smoke were made from the island and from a nearby boat. The widths of the plumes and their concentrations distributions were measured quantitatively during traverses across the plumes by a second boat. Extensive series of photographs were taken of the plumes from the surface and from the air. Meteorological measurements were made at two locations on the island, from the boats and from an aircraft. One test series was conducted during unstable conditions and a second series with neutral and stable conditions.Width of the island plume over short periods was from 1.5 to 4 times that of the boat plume with the greatest difference during stable periods. Over longer periods, the differences were somewhat greater and much of the dispersion was caused by plume meander. Height of the island plume averaged about twice that of the boat plume. Normalized maximum centerline concentrations from the boat plume were 1.4 times those of the island plume during unstable periods but about twice during stable and neutral conditions. Averaged over all tests, dispersion from the island was about twice as great as from the boat.

37949 Comparison of results using second-order moments with and without width correction to solve the advection equation. Pepper, D.W.; Long, P.E. (Savannah River Laboratory, E. I. du Pont de Nemours Co., Aiken, S. C. 29801). *J. Appl. Meteorol.;* **17**: No. 2, 228-233(Feb 1978).

The method of moments is used with and without a a width-correction technique to solve the advection of a passive scalar. The method of moments is free of numerical dispersion but suffers from numerical diffusion (damping). In order to assess the effect of the width-correction procedure on reducing numerical diffusion, both versions are used to advect a passive scalar in straight-line and rotational wind fields. Although the width-correction procedure reduces numerical diffusion under some circumstances, the unmodified version of the second-moment procedure is better suited as a general method.

37950 ANL 403 MHz radiosonde system. Hart, R.L.; George, F.R.; VanLoon, L.S.; Hicks, B.B.; Kulhanek, F.C. (Argonne National Laboratory, Argonne, Ill. 60439). *J. Appl. Meteorol.;* **17**: No. 2, 235-238(Feb 1978).

A new radiosonde system considerably improves the detection of fine temperature structure in the lower atmosphere. Special features of the system include a simple, inexpensive radiosonde which uses a monolithic timer in a rapid-response, temperature sensing audio oscillator circuit, a receiver which uses an integrated-circuit phase-lock-loop to track the audio-frequency pulses, and a simple, barometric release mechanism. The system has been used extensively in recent field investigations of the planetary boundary layer.

RADIOMETRIC TECHNIQUES

37951 Evaluation of precipitation scavenging rates of background aerosol. Hicks, B.B. (Argonne National Laboratory, Radiological and Environmental Research Division, Argonne, Ill. 60439). *J. Appl. Meteorol.;* **17**: No. 2, 161-165(Feb 1978).

Concentrations of radon daughters in falling rain have been used to derive precipitation scavenging rates of those particles with which radon daughters are associated; presumably these are the particulate component of natural, background aerosel. Scavenging rates ranging from 10^{-4} to 10^{-3} s^{-1} are deduced from a comparison of the observations with the predictions of simple models of in-cloud scavenging processes.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 36669, 37903, 37928, 37946, 37996, 37998, 38001, 38005, 38025, 38120, 38219, 38263, 38271, 38272

37952 (ANL—77-55, pp 45-46) **Fossil fuel toxicology.** 1976.

In Division of Biological and Medical Research annual report, 1976.

A program is described for the investigation of the toxicology of coal-derived effluents that will utilize a battery of cellular and mammalian test systems and end points to evaluate the toxicological effects of acute, sub-acute, and long-term, low-level exposure to gaseous and particulate effluents from combustion of coal, with special emphasis on fluidized bed combustion (FBC).

37953 (ANL—77-55, pp 75-97) **Pathology and risk assessment.** 1976.

In Division of Biological and Medical Research annual report, 1976.

Programs for providing basic data for use in evaluating the hazard to man from exposure to radiation and other energy-related pollutants are reviewed. A computer program was developed that takes the existing mortality and fertility data on a given population and applies dose-response coefficients and estimated increments of exposure to chemical or radioactive effluents and derives the excess deaths by age and sex for 5-year intervals. The program was used in an analysis of the health effects of airborne coal combustion effluents. Preliminary results are reported from a study of the influence of products of fossil fuel combustion on the spontaneous activity patterns and daily metabolic cycles of mice as a factor of age, environment, and genetic constitution. Preliminary results are reported from studies on the early and late effects of polycyclic hydrocarbons on the immune competence of mice. Studies to determine the risk to human populations from radionuclides released to the environment from nuclear energy facilities use relative toxicity and dose response data from laboratory animals of different body size and life span and comparisons of the effects of internal exposure with those of external exposure to fission neutrons or gamma sources.

37954 (ANL—77-55, pp 137-147) **Biochemistry.** 1976.

In Division of Biological and Medical Research annual report, 1976.

Progress is reported on the development of methods of density-gradient centrifugation for the isolation of subcellular fractions for use in physiological and biochemical studies. The procedures are valuable for the comparison of tissues from normal animals and those treated in various ways. The effects of atmospheric pollution generated from burning fossil fuels on plants were investigated. Results are reported from a study of the long-term effect of acid rain on the growth and Cd uptake by soybean plants. The results showed highly acid rain is harmful to crop yield and Cd has a toxic effect on metabolism.

37955 (BNL—21808-R) **Consistency of reported health effects of air pollution.** Finch, S.J.; Morris, S.C. (Brookhaven National Lab., Upton, N.Y. (USA)). [nd]. Contract EY-76-C-02-0016. 24p. Dep. NTIS, PC A02/MF A01.

Three different studies have considered the relation between various mortality rates and air pollution levels. this paper evaluates the consistency of these studies and finds some evidence of a constant proportional effect on both males and females. Two of the studies indicate a relation between air pollution and total mortality rate but differ in the estimate of the effect by a factor of fifteen. The studies generally find little relation between pollution and lung diseases and lung cancer; they disagree on heart disease and total cancer findings.

37956 (CONF-7510172—P1, pp 255-263) **Satellite global monitoring of environmental quality.** Schiffer, R.A. (National Aeronautics and Space Administration, Washington, DC). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

By its very nature, the Earth-orbiting satellite provides a unique capability for rapid repetitive quasi-synoptic measurements of the global environment and will, accordingly, play the major role in any future operational global environmental monitoring system. Nimbus G, the Air Pollution and Oceanographic Observing Satellite,

scheduled for launch in 1978, is NASA's first R and D satellite dedicated to environmental quality measurements. Atmospheric experiments on Nimbus-G will determine the feasibility of space-borne detection and mapping of important minor stratospheric constituents, and will provide a measurement of the Earth's radiation budget. Oceanographic experiments on Nimbus-G will focus on monitoring ocean color in coastal zones and will provide the first all-weather capability for measurement of sea surface temperature, a parameter of great importance in studies of the Earth's climate. A second satellite mission planned for the same general time frame is SAGE, the Stratospheric Aerosol and Gas Experiment. This satellite will provide data on stratospheric aerosol distributions and concentrations at latitudes beyond those accessible to the solar occultation aerosol sensor on Nimbus-G. NASA plans for future environmental satellites will exploit the Space Shuttle which will be available in the early 1980's, both as a launch vehicle for free-flyer satellites (e.g., EMS) and in the sortie mode (e.g., SpaceLab). Advanced remote sensors are now under development by NASA for application to both of these mission classes.

37957 (CONF-7510172—P1, pp 305-318) **Space remote sensing of smokes.** Grigorev, A.A.; Lipatov, V.B. (Univ. of Leningrad). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

The analysis of space imagery shows that due to the observations from space a diverse information on natural fires can be obtained. Space photographs can be used for the detection of smoke clouds and a smoke haze, for obtaining the data on their sizes and distribution; for the estimation of the thickness of smoke pollution; for obtaining the information on the macro and meso scale circulation of air streams; for the detection of the dynamics of smoke pollution; for studying the influence of the underlying surface on the development of fires; for the detection of the sites of the origin of fires; for the localization of the regions (zones) of the occurrence of fires; for the estimation of the regional and global pollution of the atmosphere by smokes. The main direction of the investigation is the estimation of the information content of space imagery (the determination of the necessary spectral and spatial resolution, of the frequency of the survey, etc.) with the purpose of its optimal usage for a study of fires as the sources of atmospheric pollution and the change in the face and structure of the landscape.

37958 (COO—2874-24) **Application of some robust statistical procedures to air pollution data in the San Francisco Bay area. Working paper No. 6.** Foo, C.H. (Columbia Univ., New York (USA). School of Public Health). Sep 1977. Contract EY-76-S-02-2874. 20p. Dep. NTIS, PC A02/MF A01.

Biweight regression analysis was used to analyze data on air pollution in the San Francisco Bay Area. Relationships between daily maximum hourly averages of total oxidant concentration and selected weather variables were examined. The study of daily variations of NO_1,NO_2 and total oxidant calculated by using the 10 percent trimmed mean is also included. The data base consists of the hourly concentrations of the pollutants at San Jose and Redwood City monitoring stations during July, August, and September in 1974.

37959 (COO—2874-27) **Exposure data for the study of acute health effects of air pollution.** Goldstein, I.F. (Columbia Univ., New York (USA). School of Public Health). 1977. Contract EY-76-S-02-2874. 18p. Dep. NTIS, PC A02/MF A01.

Portions of document are illegible.

The use of aerometric network data has been criticized before on the grounds that it might give an unreliable picture of air pollution population exposure. However, the extensive data obtained from networks is still being used for studies of health effects of air pollution. This study uses a rigorous approach in analyzing these data to test their suitability for studies of acute health effects of air pollution. New York City, with one of the most extensive aerometric networks, consisting of 40 air pollution monitoring stations, is taken as an example. Three years of hourly SO_2 readings and bi-hourly readings of smokeshade were analyzed. The use of one aerometric station to represent the daily exposure of the population of New York City as has been done in previous studies is shown to be invalid. The use of individual monitoring stations of the New York City aerometric network to represent the day-to-day exposure to SO_2 and smokeshade of the populations surrounding these monitoring stations is examined, with results showing that further work will be necessary before such an approach is justified.

37960 (COO—2874-28) **Methodological problems arising from the choice of an independent variable in linear regression, with application to an air pollution epidemiological study.** Goldstein, I.F.; Goldstein, M.; Fleiss, J.L.; Landovitz, L. (Columbia Univ., New York (USA). School of Public Health; B.K.T. Displays Ltd., London (UK); City Univ. of New York, N.Y. (USA). Graduate Center). 1977. Contract EY-76-S-02-2874. 16p. Dep. NTIS, PC A02/MF A01.

In epidemiological studies using linear regression, it is often necessary for reasons of economy or unavailability of data to use as the independent variable not the variable ideally demanded by the hypothesis under study but some convenient practical approximation to it. If the correlation coefficient between the "practical" and "ideal" variables can be obtained, then a range of uncertainty can be obtained within which the desired regression coefficient of dependent on ideal variable may lie. This range can be quite wide, even if the practical and ideal variables are fairly well correlated, expecially if the regression of dependent on practical variable explains only a small part of the variance in the dependent variable. These points are illustrated with data and observed regression coefficients from an air pollution epidemiological study, in which pollution measured at one station in a large metropolitan area (containing 40 aerometric stations) was used as the practical approximation to the city-wide average pollution. The uncertainties in the regression coefficients were found to exceed the regression coefficients themselves by factors of 15 to 150.

37961 (COO—2874-29) **Relation of air pollution to mortality: a critique.** Goldstein, I.F.; Goldstein, M.; Landovitz, L. (SIAM Inst. for Mathematics and Society, Philadelphia, Pa. (USA)). Dec 1977. Contract EY-76-S-02-2874. 11p. Dep. NTIS, PC A02/MF A01.

A study of the relation between SO_2 and smoke-shade in the surface air of New York City and deaths resulting from respiratory and heart diseases is discussed. The need to use data from a number of sampling stations in any epidemiological study on the health effects of air pollutants is stressed. It is pointed out that the complicated effects of weather on the environmental transport of air pollutants and the variations in statistical methods used may lead to eronious conclusions as to the cause of deaths.

37962 (COO—2874-30) **SIMS three year study on statistics and environmental factors in health. Technical progress report No. 2.** (SIAM Inst. for Mathematics and Society, Philadelphia, Pa. (USA)). Dec 1977. Contract EY-76-S-02-2874. 47p. Dep. NTIS, PC A03/MF A01.

Progress is reported on a study of statistical methods for the correlation of environmental factors and health effects, with emphasis on the effects of air pollution. Statistical methods and models for describing the effects of the environment, measured in terms of pollution and weather variables on health, so far measured only in terms of respiratory diseases, are discussed. Plans for conducting a six-city pollution health study are also discussed. A list of publications during 1976 and 1977 is included.

37963 (LA—7198-MS(Vol.1)) **Some atmospheric tracer experiments in complex terrain at LASL: experimental design and data.** Archuleta, J.; Barr, S.; Clements, W.E.; Gedayloo, T.; Wilson, S.K. (Los Alamos Scientific Lab., N.Mex. (USA)). Mar 1978. Contract W-7405-ENG-36. 40p. Dep. NTIS, PC A03/MF A01.

Two series of atmospheric tracer experiments were conducted in complex terrain situations in and around the Los Alamos Scientific Laboratory. Fluorescent particle tracers were used to investigate nighttime drainage flow in Los Alamos Canyon and daytime flow across the local canyon-mesa complex. This report describes the details of these experiments and presents a summary of the data collected. A subsequent report will discuss the analysis of these data.

37964 (LBL—6819) **Lawrence Berkeley Laboratory, Energy and Environment Division, atmospheric aerosol research. Annual report, 1976—1977.** Novakov, T.; Chang, S.G.; Hollowell, C.D. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 1977. Contract W-7405-ENG-48. 111p. Dep. NTIS, PC A06/MF A01.

Separate abstracts were prepared for eleven sections of this report.

37965 (LBL—6819, pp 8-17) **Characterization of the carbonaceous component of ambient and source particulate samples by an optical absorption technique.** Rosen, H.; Hansen, A.D.A.; Dod, R.L.; Novakov, T. 1977.

In Lawrence Berkeley Laboratory, Energy and Environment Division, atmospheric aerosol research. Annual report, 1976—1977.

The optical attenuation and total carbon content of a number of ambient and mobile-source exhaust samples were measured. In all cases there was a strong correlation between the carbon content and the attenuation. It has been suggested that most of the carbonaceous species in the Los Angeles Air Basin in the summer are of secondary origin, based on the concept of mass balance using Pb as a tracer. Most of the primary carbon is assumed to originate from mobile sources, while the contribution of other sources relative to automobile exhaust gases is estimated from an emission inventory. The contribution of mobile sources is determined by assuming that such emissions are characterized by a C/Pb ratio of approximately 1.7. In

the ambient samples, C/Pb ratios of the order of 10 are found, and the deviation from the automotive C/Pb ratio, after taking into account a small contribution from other sources, is attributed to the secondary production of organic carbon. Sources other than automobiles (e.g., diesels, home heating, aircraft, industry) make a major contribution to the carbon balance. It is also possible that there are some difficulties in using Pb as a tracer for mobile source emissions. For example, differences in the transport properties of lead and carbon could affect the C/Pb ratio. Also, we have found that the C/Pb ratio may depend markedly on driving conditions. Tunnel samples typically had a C/Pb ratio of approximately equal to 1 while parking garage samples taken under "start-stop" conditions had a C/Pb ratio of approximately equal to 8. This is quite reasonable since under these conditions we would expect the combustion process to be more incomplete and therefore produce more carbonaceous emissions.

37966 (NUREG—0373) **Dispersion in the wake of a model industrial complex.** Hatcher, R.V.; Meroney, R.N.; Peterka, J.A.; Kothari, K. (Colorado State Univ., Fort Collins (USA). Dept. of Civil Engineering). Jun 1977. 245p. NTIS $9.50.

Portions of document are illegible.

Models (1:200 scale) of the EOCR reactor building and surrounding silo and tank buildings at the Idaho National Engineering Laboratory, Idaho Falls, Idaho were put into the Meteorological Wind Tunnel at Colorado State University for the purpose of studying the effects of building wakes on dispersion. Flow visualization was done and concentration measurements were taken. The test program consisted of systematic releases from ground, building height, and stack height sources with no appreciable plume rise. The program was repeated for cases of moderately unstable, neutral, moderately stable, and stable conditions in the wind tunnel. Results show that the buildings significantly alter the dispersion patterns and the addition of any extra buildings or slight terrain change in the immediate vicinity of the building has a major effect. In the near wake region the effects of stratification were still evident causing slightly higher concentrations for stable conditions and slightly lower for unstable. Current dispersion models are discussed and evaluated that predict concentrations in the building wake region.

37967 (UCRL—13822) **Sulfur dioxide measurements and mass flux calculations in support of the AMBIENS field experiment.** Peache, M.A. (Environmental Measurements, Inc., San Francisco, Calif. (USA)). 20 Jan 1978. Contract W-7405-ENG-48. 62p. Dep. NTIS, PC A04/MF A01.

During the first two weeks of October, 1977, a 12-day field experiment was conducted to estimate the rate of SO_2 transformation into sulfate by measuring the components of the sulfur balance in a hypothetical box region. To obtain the measurements necessary to define the atmospheric components of the Planetary Boundary Layer, a PBL site was located in a cornfield fifteen kilometers east of Shelbyville, Indiana. Vertical temperature and wind profiles were made at this location, as well as a variety of pollutant measurements. Two instrumented aircraft were used to measure pollutant and tracer concentrations along the sides of the box in an attempt to quantify the flux into and out of the study region. Results are reported from measurements of vertically integrated SO_2 concentrations around the edges of the box using a correlation spectrometer. SO_2 mass flux calculations were subsequently made using the SO_2 data in conjunction with vertical wind profile measurements. The instrumentation and techniques used are discussed.

37968 (UCRL—50042-77) **Annual report of Lawrence Livermore Laboratory to the High Altitude Pollution Program, 1977.** Luther, F.M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 30 Sep 1977. Contract W-7405-ENG-48. 102p. Dep. NTIS, PC A06/MF A01.

The High Altitude Pollution Program (HAPP) was initiated by the Federal Aviation Administration to ensure that aircraft engine emissions in the stratosphere will not result in unacceptable effects on the biosphere. Lawrence Livermore Laboratory (LLL) has participated in HAPP since July 1975. The primary research emphasis at LLL is on numerical modeling of the atmospheric response to stratospheric perturbations. The modeling effort at LLL covers four major research areas: photochemical kinetics, coupled kinetics and transport, radiative transfer, and meteorological analysis. Progress since July 1, 1976 is reported.

37969 **Livermore regional air quality model: I. concept and development.** MacCracken, M.C.; Wuebbles, D.J.; Walton, J.J.; Duewer, W.H.; Grant, K.E. (Lawrence Livermore Laboratory, University of California, Livermore 94550). *J. Appl. Meteorol.;* **17**: No. 3, 254-272(Mar 1978).

By using the Eulerian form of the mass conservation equation integrated vertically from the surface to the base of the inversion, two regional air quality models (LIRAQ-1 and LIRAQ-2) have been developed for use in the San Francisco Bay Area. The models consider the complex topography, changing meteorology and detailed source emission patterns in generating surface and vertical average pollutant concentrations with grid resolutions of 1, 2 or 5 km. The focus of LIRAQ-1 is the treatment of transport and dispersion of relatively nonreactive species, accomplished through use of a sophisticated transport prescription. The LIRAQ-2 model, employing a simpler transport scheme, treats photochemically active pollutants and incorporates a photochemical reaction set involving 19 species.

37970 **Livermore regional air quality model: II. verification and sample application in the San Francisco Bay Area.** Duewer, W.H.; MacCracken, M.C.; Walton, J.J. (Lawrence Livermore Laboratory, University of California, Livermore 94550). *J. Appl. Meteorol.;* **17**: No. 3, 273-311(Mar 1978).

Topographic, meteorological source emission and atmospheric pollutant concentration data have been assembled for use in verifying the LIRAQ-1 and LIRAQ-2 regional air quality models in the San Francisco Bay Area. These data, collected primarily during the high-pollution period of 26-27 July 1973, indicate that the temporal and spatial phasing for concentrations of carbon monoxide, ozone and nitrogen oxides can be adequately represented by the models. Sensitivity studies indicate that initial and horizontal boundary conditions as well as grid size and subgrid-scale effects, while very significant in predicting air quality on the local scale, are less important in dealing with regional concentrations of pollutants than are emissions, meteorological conditions and vertical boundary conditions.

37971 **Mass-consistent model for wind fields over complex terrain.** Sherman, C.A. (Lawrence Livermore Laboratory, University of California, Livermore 94550). *J. Appl. Meteorol.;* **17**: No. 3, 312-319(Mar 1978).

An adjustment model was developed to provide a pollutant transport model with input wind fields that are mass-consistent, three-dimensional, and also representative of the available meteorological measurements. Interpolated three-dimensional mean winds were adjusted in a weighted least-squares sense to satisfy the continuity equation within the volume specified. The upper and lateral boundaries above topography were assumed to be open air and thus allowed mass flow through the boundaries. The bottom boundary was determined by the topographic elevations of the area being studied. The topographic boundary was assumed to be solid.

37972 **Puff-on-cell model for computing pollutant transport and diffusion.** Sheih, C.M. (Atmospheric Physics Section, Radiological and Environmental Research Division, Argonne National Laboratory, Argonne, Ill. 60439). *J. Appl. Meteorol.;* **17**: No. 2, 140-147(Feb 1978).

A scheme is developed to minimize the pseudo-diffusion which arises in numerical solutions of finite-difference equations of turbulent diffusion and transport. In the present model, the subgrid scale distribution of the pollutant concentration is parameterized by a Gaussian puff. At each time step the concentration within each grid volume is characterized by a Lagrangian puff. The center of each Lagrangian puff is advected by the mean wind and its boundaries are expanded or contracted by diffusive displacements, computed from the values of concentration, atmospheric turbulent diffusivity, and the gradient of pollutant concentration between the adjacent grid volumes. The standard deviation of the puff is parameterized as a linear combination of the grid length and the diffusive displacement. The constants in the parameterization are determined by calibrating the standard deviation of the puff width predicted by the numerical model against that of an analytical solution. The pollutant is then distributed back to the surrounding Eulerian grid volumes, preserving the first and the second moments of the concentration distribution. The use of the model is illustrated by predicting the vertical concentration distribution of sulfur dioxide and sulfate for a period of 5 days. Furthermore, the requirement for realistic surface-layer parameterization in such numerical models is demonstrated by comparing the results of the constant-flux layer parameterization based upon the modern similarity theory with those of the conventional linear-profile approximation.

37973 **Filtration theory for granular beds.** Schmidt, E.W. (Battelle Columbus Labs., OH); Gieseke, J.A.; Gelfand, P.; Lugar, T.W.; Furlong, D.A. *J. Air Pollut. Control Assoc.;* **28**: No. 2, 143-146(Feb 1978).

A study has been made of the amounts of cadmium recovered by a variety of reagents and extraction procedures from soils to which Cd has been added. Correlation of these results with the Cd content of radish plants (Raphanus sativus L. cultivar French Breakfast Crimson (Suttons)) grown in these soils has shown that the most sensitive of several possible indices to Cd uptake by plants is the amount extracted by a 1-hour shaking with 1N ammonium nitrate solution at a soil/solution ratio of 1:10 (wt/vol). The greater efficiency of this extractant compared with other proposed extractants is ascribed to the system reflecting the natural pH of the soil which has a marked effect on cadmium availability to plants.

37974 Quality assurance: a systematic approach for a noncontinuous monitoring network. Hoyle, W.C.; Kolaz, D.; True, D.K. (Iowa Dept. of Environmental Quality, Des Moines). *J. Air Pollut. Control Assoc.;* **28**: No. 2, 109-114(Feb 1978).

A number of impediments to air quality data base integrity have been evaluated with particular emphasis on noncontinuous high-volume sampler and gas bubbler data. Where sampling stations remote from the laboratory are operated by part-time personnel, special quality control problems arise. Lack of training and motivation of the part-time operators have been shown to be common deficiencies and a method to correct these deficiencies is offered. In addition, potential difficulties such as thermal degradation of the tetrachloromercurate-SO_2 complex in an SO_2 bubbler sample are pointed out as problems which require special precautions to insure sample preservation. A quality assurance checklist has been developed for laboratories with air monitoring responsibilities. This checklist covers high-volume samplers, gas bubblers and various continuous instrumentation. Each checkpoint has been assigned a priority based upon the reversibility of errors due to deviations from the prescribed practice. A number of important checks have been discussed with respect to their effect on data when deviations from the standard practice occur.

37975 Legal aspects of remote sensing and air enforcement. Griggs, M.; Ludwig, C.B. (Science Applications, Inc., La Jolla, CA). *J. Air Pollut. Control Assoc.;* **28**: No. 2, 119-122(Feb 1978).

The legal and technical aspects involved in the application of remote monitors in air enforcement programs are discussed. It is found that some of the instruments presently under development or being field tested are good candidates as enforcement monitors while others are not suited. The advantages and disadvantages of the remote sensors as compared to the in-stack monitors are discussed.

37976 Diurnal variation of the stability factor in the simple ATDL urban dispersion model. Hanna, S.R. (National Oceanic and Atmospheric Administration, Oak Ridge, TN). *J. Air Pollut. Control Assoc.;* **28**: No. 2, 147-150(Feb 1978).

The simple ATDL urban dispersion model is based on the formula $chi_0(g/m^3) = CQ\ (g/m^2s)/U(m/s)$. The diurnal variation of the stability factor C, which can be thought of as the width of the urban area divided by the vertical dispersion of the pollution cloud, has not before been satisfactorily estimated. Using observed diurnal variations of CO concentrations and traffic frequencies reported by DeMarrais of the EPA for many stations in the states of Maryland, New Jersey, and Colorado, and using wind data from these states, hourly values of $C = chi_0\ U/Q$ were calculated. The ratio of C to the daily average anti C is found to equal about 2.5 at 4 A.M., drops to about 0.5 by 9 A.M., and remains at 0.5 until about 6 P.M., when it starts to climb slowly again. Application of this new stability factor to independent CO data from Los Angeles yields correlations between measured and predicted concentrations of about 0.7.

37977 Association of oxidant episodes with warm stagnating anticyclones. Altshuller, A.P. (Environmental Protection Agency, Research Triangle Park, NC). *J. Air Pollut. Control Assoc.;* **28**: No. 2, 152-155(Feb 1978).

Warm anticyclones should lead not only to the buildup of primary pollutants, but also to the buildup of pollutants which are formed by secondary chemical processes in the atmosphere. Ozone and sulfates are pollutants which can be formed through such processes. In the last several years experimental work has been done especially in midwest areas of the U.S. associating a number of individual periods of elevated ozone and sulfate concentrations with warm stagnating anticyclones. During such periods both O_3 and $SO_4^=$ concentrations have been demonstrated to be elevated over extended urban and rural areas in the midwestern U.S. Because of the possible health and welfare effects associated with such periods of elevated pollution a better knowledge of frequency with which such periods occur is needed. The climatological analysis of warm stagnating anticyclones indicates the geographical areas substantially impacted. These stagnations tend to concentrate in the southeastern U.S. throughout most of the year. Computations and comparisons show that stagnation periods as defined in the climatological analysis used can be associated with a substantial portion of days in August and September with elevated oxidant concentrations. Other meteorological conditions such as persistent winds causing long range transport aloft also contribute to elevated oxidant episodes. Longer stagnation periods with prolonged exposures of humans, animals and vegetation to high pollutant concentrations may be of greater concern than the same number of days distributed over longer time periods.

37978 Respirable fraction of airborne dust: quantitative descriptions, formal definitions, and performance characteristics of samplers matched to them. Mercer, T.T. (Univ. of Rochester, NY). *J. Test. Eval.;* **6**: No. 1, 9-19(Jan 1978).

A rational system for monitoring atmospheres suspected of containing insoluble toxic particles requires a method that will provide a sample in which all particles are represented in proportion to their "respirable fraction", that is, in proportion to the probability that they would be deposited in the nonciliated region of the lung, if inhaled by an average man. Various organizations concerned with occupational health have advanced formal definitions of respirable fraction, and samplers operating in accordance with those definitions are widely used for both personal and general area monitoring. In this discussion, quantitative descriptions of respirable fraction, the formal definitions derived from them, and the performance characteristics of respirable fraction samplers are reviewed. The samplers are shown to perform adequately for their respective definitions, but in general the definitions themselves significantly overestimate respirable fraction as determined from recent experimental data.

37979 Instrumental sensing of stationary source emissions. Herget, W.F.; Conner, W.D. (Environmental Protection Agency, Research Triangle Park, NC). *Environ. Sci. Technol.;* **11**: No. 10, 962-967(Oct 1977).

Several techniques have been developed that can measure the concentration and velocity of gaseous species and particulate opacity. The velocity measurement is needed so that a mass emission rate may be determined. In order to evaluate the accuracy, utility, and state of development of some of these techniques, a series of measurements have been conducted at coal-burning power plants, and the results of the remote measurements were compared with the results of instack measurements made using the EPA Reference Methods. The techniques studied in these programs are: (1) infrared gas-filter correlation radiometry (GFCR), for SO_2 concentration, (2) Fourier-transform infrared spectroscopy (FTIS), for SO_2 concentration, (3) ultraviolet matched-filter correlation spectroscopy (MFCS), for SO_2 concentration, (4) infrared and ultraviolet television (IRTV and UVTV), for velocity and SO_2 concentration, (5) infrared laser-Doppler velocimetry (LDV), for plume velocity, and (6) visible laser radar (lidar), for plume opacity. The emphasis in the work described on measurements of gaseous species concentrations has been on techniques not including lasers because of overall practicality. For remote velocity and opacity measurements, techniques using lasers are necessary.

37980 NO/sub x/—O_3 photochemistry in power plant plumes: comparison of theory with observation. White, W.H. (Meteorology Research, Inc., Altadena, CA). *Environ. Sci. Technol.;* **11**: No. 10, 995-1000(Oct 1977).

Measurements were made by an instrumented aircraft in the plume from a large, coal-fired power plant. In all traverses (out to 45 km downwind), ozone concentrations within the plume were depressed below background levels. The depth of this ozone deficit and the ratio of NO to NO/sub x/ in the plume both decreased with increasing distance from the plant. A model is presented which accurately predicts the observed plume profiles of O_3, NO, and NO/sub x/ from the background conditions, plume geometry, and basic photolytic cycle. Free-radical reactions within the plume did not significantly affect oxidant concentrations at the distances sampled.

37981 Nitrate formation in atmospheric aerosols. Orel, A.E.; Seinfeld, J.H. (California Inst. of Tech., Pasadena). *Environ. Sci. Technol.;* **11**: No. 10, 1000-1007(Oct 1977).

Equilibrium nitrate levels in aqueous solution in the presence of sodium chloride, nitric oxide, nitrogen dioxide, sulfur dioxide, carbon dioxide, ammonia, and sulfuric acid are calculated. Nitrate levels in solution are of the order of those observed in the atmosphere when the gaseous concentrations are at typical urban levels. Sulfate levels in such solutions are predicted to be relatively low in the absence of oxidation catalysts. When sulfate formation is assumed to occur by gas-phase oxidation of sulfur dioxide to sulfuric acid followed by absorption of the sulfuric acid in aerosols, predicted nitrate and sulfate size distributions are in qualitative agreement with those observed in the atmosphere.

37982 Comparison of levels of trace elements extracted from fly ash and levels found in effluent waters from a coal-fired power plant. Dreesen, D.R.; Gladney, E.S.; Owens, J.W.; Perkins, B.L.; Wienke, C.L.; Wangen, L.W. (Los Alamos Scientific Lab., NM). *Environ. Sci. Technol.;* **11**: No. 10, 1017-1019(Oct 1977).

Trace elements were extracted from a coal-fired power plant electrostatic precipitator ash with nitric acid, hydrochloric acid, citric acid, redistilled water, and ammonium hydroxide as extractants. Effluent waters at this plant were sampled to assess the elevation of trace element concentrations compared with intake waters. The results showed a positive correlation between those elements most extractable by water (B, F, Mo, and Se) or acid (As, B, Cd, F, Mo, and Se) and those elements most elevated in effluent waters (As, B, F, Mo, and Se).

37983 Sulphur deposit account. Barnes, R.A. *Nature (London);* **268**: No. 5616, 92-93(14 Jul 1977).

Some aspects of sulphur transport which were covered on the final report of the OECD study on the long-range transport of air

pollution within north-western Europe are discussed. Methods of collecting and analysing data for the year 1974, are outlined, and estimates of the sulphur emitted and received during 1974 in the eleven countries involved are tabulated.

37984 Ambient air contamination micron and submicron particles from welding operations. Lannefors, H.O. (Lund Inst. of Tech., Sweden); Akselsson, K.R. *Bull. Environ. Contam. Toxicol.;* **17**: No. 5, 521-527(May 1977).

The combination of impactor sampling and analyses of size fractions by particle induced x-ray emission analysis (PIXE) is a very sensitive tool for revealing particulate matter of industrial indoor origin in the presence of particulate matter from other anthropogenic and natural sources. In a small Swedish town (population less than 50,000) with an industrial area employing of the order of three to five thousand workers, two sampling sites at rooftop locations were chosen. The sites were fitted with single orifice cascade impactors of Battelle design. From the results, the increases of the concentration of iron, potassium and manganese were evident. Although the reported values are below air-quality limit values, there are some reasons for being careful. Firstly, the increases are most significant in submicron particles. Secondly, with different weather conditions and from other industrial areas, indoor contribution could be orders of magnitude larger. Thirdly, in PIXE analysis only elemental constituents heavier than about sulphur are detected and there may be other lighter constituents. Thus considerable attention should be given to the ambient air when planning means of improving work environment and when allocating new industrial areas.

37985 Geoengineering and the carbon dioxide problem. Marchetti, C. *Clim. Change;* **1**: No. 1, 59-68(Mar 1977).

The problem of carbon dioxide control in the atmosphere is tackled by proposing a kind of fuel cycle for fossil fuels where carbon dioxide is partially or totally collected at certain transformation points and properly disposed of. Carbon dioxide is disposed of by injection into suitable sinking thermohaline currents that carry and spread it into the deep ocean that has a very large equilibrium capacity. The Mediterranean undercurrent entering the Atlantic at Gibraltar has been identified as one such current: it would have sufficient capacity to deal with all carbon dioxide produced in Europe even in the year 2100.

37986 Climate and energy: a scenario to a 21st century problem. Flohn, C.H. *Clim. Change;* **1**: No. 1, 5-20(Mar 1977).

The energy contribution of anthropogenic climatic fluctuations has been estimated to a gain of 15-20 TW, in comparison with a gain or deficit of 100-300 TW from natural processes responsible for the observed climatic fluctuations of the last 200 years. A dominant role of an increase of carbon dioxide by a factor 2-5 in the next century, accompanied by side effects acting in the same direction, seems to be most likely. Under the assumption of constant natural factors anthropogenic warming and its effects on the Arctic sea-ice may successively lead to climatic states as in 1031-60, in the early Middle Age (900-1200) and in the climatic optimum period ca 5000 BP. Finally it may result in a complete destruction of the Arctic sea-ice with a drastic shift of all climatic belts towards north, extending even to the interior tropics.

37987 Gas-to-particle conversion in photochemical smog: aerosol growth laws and mechanisms for organics. Heisler, S.L.; Friedlander, S.K. (California Inst. of Tech., Pasadena). *Atmos. Environ.;* **11**: No. 2, 157-168(1977).

Experiments were conducted to determine particle growth rates as a function of particle size in the presence of reacting organic gases. Hydrocarbons and oxides of nitrogen were added to unfiltered ambient air in an 80 m^3 Teflon bag exposed to natural solar radiation. The ensuing photochemical reactions resulted in growth of the particles originally present. The size distribution of the evolving aerosol was measured in the size range above 0.3 μm using a single particle optical counter. From the change in the size distribution with time, the particle growth rate was determined as a function of size and time. The results could be explained by a mechanism based on diffusion to the particles of condensable gases formed by chemical reaction, with a critical particle size below which growth did not occur (Kelvin effect). A growth law corresponding to this mechanism was used to compute a smog aerosol size distribution which agreed well with atmospheric measurements.

37988 Photochemical production of ozone in Western Europe (1971—1975) and its relation to meterology. Guicherit, R. (Research Inst. for Environmental Hygiene TNO, Delft, Netherlands); van Dop, H. *Atmos. Environ.;* **11**: No. 2, 145-155(1977).

A study has been made of the occurrence of high ozone levels (> or = to 0.08 ppM) in Western Europe, during 1969-1975. It appeared that during some episodes ozone levels could be extremely high, both in rural and urban environments, over distances of some thousands of kilometers. This has been ascribed to photochemical processes due to the occurrence on a large scale of favorable meteorological circumstances. During these periods a slowly moving or quasi-stationary anticyclone was situated over Western Europe. Precursor concentrations seemed to be present in a sufficient measure all over the area to initiate photochemical processes. Therefore, though airmass trajectories were determined ending in four countries, no source areas could be indicated. The parameters of major importance for the occurrence of photochemical ozone are the daily average windspeed, the daily maximum temperature and the solar radiation. In Delft (The Netherlands) a correlation of 0.7 has been found between high ozone values and these meteorological parameters. The observations made in Delft suggest that the hydrocarbon-nitrogen dioxide ratio determined the final photochemical ozone concentration rather than the values of the separate concentrations.

37989 Extension of atmospheric dispersion models to incorporate fast reversible reactions. Peters, L.K. (Univ. of Kentucky, Lexington); Richards, L.W. *Atmos. Environ.;* **11**: No. 2, 101-108(1977).

Atmospheric dispersion with simultaneous chemical reaction is important with many air pollutants. A method is presented for separating the chemical reaction calculations from the atmospheric dispersion calculations in a model where the chemistry can be represented by one or a series of stoichiometric reactions. It is shown that when the chemical reactions are fast and reversible, the concentration of all chemical species can be calculated from a system of algebraic equations along with dispersion calculations for an inert species, rather than by the integration of differential equations. The conditions under which this separation is valid are discussed. Practical applications of this method include modeling the conversion of emitted NO to NO_2 by reaction with ambient ozone, and modeling the reaction of emitted sulfuric acid with ambient ammonia.

37990 Source reconciliation of atmospheric hydrocarbons, 1974. Mayrsohn, H.; Crabtree, J.H.; Kuramoto, M.; Sothern, R.D.; Mano, S.H. (State of California Air Resources Board Lab., El Monte, CA). *Atmos. Environ.;* **11**: No. 2, 189-192(1977).

In a prior study the authors developed a technique whereby atmospheric hydrocarbons could be related or reconciled to their sources of emission. This paper describes the results of a similar study expanded to cover many additional sampling sites over a longer period of time. The results of nine hundred analyses at eight sites demonstrate that the source contributions were: automotive exhaust—53%; gasoline—12%; gasoline vapor—10%; commercial natural gas—5%; geogenic natural gas—19%; and liquified petroleum gas—1%, as nonmethane hydrocarbons through C_{10}.

37991 Estimation of transformation rate of SO_2 to SO_4 from atmospheric concentration data. Alkezweeny, A.J.; Powell, D.C. (Battelle Pacific Northwest Labs., Richland, WA). *Atmos. Environ.;* **11**: No. 2, 179-182(1977).

The transformation rate of SO_2 to sulfate is estimated from data collected by aircraft following a tetroon northeast of St. Louis, Missouri, on 10 and 11 August 1975. Assuming deposition velocities of 1 cm s^{-1} and 0.1 cm s^{-1} for SO_2 and sulfate, respectively, the analysis including 90% confidence limits, yields a rate of 0.14 +- 0.04 h^{-1} for the first day, and 0.10 +- 0.02 h^{-1} for the second. The confidence limits do not preclude the likelihood that the rate was the same for both days, in which case it would have been 0.10 to 0.12 h^{-1}.

37992 Attempt to estimate the continental sulphur emission on the basis of atmospheric measurements. Meszaros, E.; Varhelyi, G. (Inst. for Atmospheric Physics, Budapest). *Atmos. Environ.;* **11**: No. 2, 169-172(1977).

The paper demonstrates the possibility of calculating sulfur emission on the basis of atmospheric measurements. The calculation of the total sulfur emission is done by means of a box model. The box is situated in Central Europe over a territory of 200 x 340 km^2. It was found that the yearly total sulfur emission rate is 3.1 ton S km^{-2}.

37993 Turbulent diffusion in the Ekman boundary layer. Paegle, J.N.; Kao, S.K. (Univ. of Utah, Salt Lake City). *Atmos. Environ.;* **11**: No. 2, 95-100(1977).

Numerical models are developed to simulate and quantitatively predict the dispersion of pollutants emitted from a ground source in the Ekman boundary layer for three different boundary conditions. It is shown that the maximum concentration generally shifts toward the right in the Northern Hemisphere, left in the Southern Hemisphere, with increasing height as a consequence of the effects of the Coriolis and frictional forces in the planetary boundary layer. In the case of reflecting upper and lower boundaries, concentration tends to be uniformly distributed along the vertical as the radial distance increases. In the case of total absorption upper boundary and a reflecting lower boundary, at all points the concentration is lower than that in the previous case, as expected. In the case of total absorption upper and lower boundary, the distribution of concentration becomes different from the two previous cases in that the maximum concentration occurs at higher levels. In the two latter cases, the maximum concentration axis at lower levels is at a large

angle to the geostrophic wind while at higher levels it is close to the geostrophic wind direction. These results indicate that diffusion in the planetary boundary layer differs greatly from that in the surface boundary layer.

37994 Urban and industrial air pollution in Houston Texas. I. Hydrocarbons. Siddiqi, A.A.; Worley, F.L. Jr. (Univ. of Houston, TX). *Atmos. Environ.;* **11**: No. 2, 131-143(1977).

During the Summer of 1973 and 1974, ambient air samples were collected at sites in downtown Houston and the near-by Pasadena and La Porte industrial complex to determine the hydrocarbon composition in relation to emission sources. Ground level samples were collected at one hour intervals and analyzed for C_1-C_6 hydrocarbons without delay in order to avoid any sample deterioration due to storage. In addition at selected times, helicopters were used to sample at 500 and 1000 ft elevation. Meteorological conditions were recorded and their effects on the hydrocarbon composition evaluated. As expected, the hydrocarbon spectrum of downtown Houston air resembled that of auto exhaust and showed a strong dependence on traffic density and local meteorology. The hydrocarbon composition at the industrial sites largely depended on the wind direction and magnitude, i.e. local point sources. This study has also indicated removal of some of the hydrocarbons by the photochemical reactions.

37995 Coordinated Mediterranean Pollution Monitoring and Research Program. Keckes, S. *Ambio;* **6**: No. 6, 327-328(1977).

At the Intergovernmental Conference on the Protection of the Mediterranean (Barcelona 1975) a Coordinated Mediterranean Pollution Monitoring and Research Program (MED POL) was approved. The pilot phase of the program, consisting of several projects, will last until the end of 1978. At present almost 80 Mediterranean research centers actively participate in MED POL under the over-all coordination of UNEP and in cooperation with eight specialized bodies of the United Nations system.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 36952, 37953, 37966, 38219, 38239

37996 (ANL—78-26) **Environmental monitoring at Argonne National Laboratory. Annual report.** Golchert, N.W.; Duffy, T.L.; Sedlet, J. (Argonne National Lab., Ill. (USA)). Mar 1978. Contract W-31-109-ENG-38. 100p. Dep. NTIS, PC A05/MF A01.

The results of the environmental monitoring program at Argonne National Laboratory for 1977 are presented and discussed. To evaluate the effect of Argonne operations on the environment, measurements were made for a variety of radionuclides in air, surface water, Argonne effluent water, soil, grass, bottom sediment, and foodstuffs; for a variety of chemical constituents in air, surface water, and Argonne effluent water; and of the environmental penetrating radiation dose. Sample collections and measurements were made at the site boundary and off the Argonne site for comparison purposes. Some on-site measurements were made to aid in the interpretation of the boundary and off-site data. The results of the program are interpreted in terms of the sources and origin of the radioactive and chemical substances (natural, fallout, Argonne, and other) and are compared with applicable environmental quality standards. The potential radiation dose to off-site population groups is also estimated.

37997 (DP—1487) **Calculation of particulate dispersion in a design-basis tornadic storm from the Babcock and Wilcox Plant, Leechburg, Pennsylvania.** Pepper, D.W. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). Mar 1978. Contract EY-76-C-09-0001. 26p. Dep. NTIS, PC A03/MF A01.

A three-dimensional numerical model is used to calculate ground-level air concentration and deposition (due to precipitation scavenging) after a hypothetical tornado strike at the Babcock and Wilcox Plutonium Fabrication Facility at Leechburg, Pennsylvania. Plutonium particles lss than 20 μm in diameter are assumed to be lifted into the tornadic storm cell by the vortex. The rotational characteristics of the tornadic storm are embedded within the larger mesoscale flow of the storm system. The design-basis translational wind values are based on probabilities associated with existing records of tornado strikes in the vicinity of the plant site. Turbulence exchange coefficients are based on empirical values deduced from experimental data in severe storms and from theoretical assumptions obtained from the literature. The quasi-Lagrangian method of moments is used to model the transport of concentration within a grid cell volume.

37998 (DPSPU—78-30-1) **Environmental monitoring in the vicinity of the Savannah River Plant. Annual report, 1977.** (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Plant). 1977. Contract EY-76-C-09-0001. 70p. Dep. NTIS, PC A04/MF A01.

The concentration of radioactivity added by the Savannah River Plant operations to the environs during 1977 was, for the most part, too small to be distinguished from natural background radiation and fallout from worldwide nuclear weapon tests. Beta activity in particulate air filters was about two times the 1976 level and was due entirely to global fallout. Tritium oxide in air at the plant perimeter was greater than in air at more distant locations; the average concentration at the plant perimeter (65 pCi/m^3) was 0.03% of the Concentration Guide (CG). Tritium, ^{137}Cs, and ^{90}Sr were the only radionuclides of plant origin detectable in Savannah River water by routine analyses. None of these had an average concentration exceeding 0.2% of the CG in river water sampled 8 mi downstream from the plant. The tritium concentration in river water immediately downstream of the plant (4.8 pCi/ml, including 0.5 pCi/ml background river contribution) represented the highest CG percentage (0.16) of the three radionuclides measured in river water. Special research programs using ultra-low-level techniques may detect trace quantities of other radionuclides of plant origin. Radioactive materials in river fish also continued very low (0.2 pCi/g ^{137}Cs maximum). Annual analyses of plant perimeter soil samples 0-5 cm deep) showed deposition of ^{137}Cs (52 mCi/km^2) and ^{239}Pu (1.2 mCi/km^2) within the range normally found in global fallout. ^{238}Pu in all soil samples was near the sensitivity of the analysis (approximately 0.1 mCi/km^2). For 1977, the calculated annual average dose from atmospheric releases of radioactive materials from SRP was 0.8 millirem (mrem) at the plant perimeter.

37999 (GEPP—363) **Environmental monitoring report, 1977.** (General Electric Co., St. Petersburg, Fla. (USA). Neutron Devices Dept.). Apr 1978. Contract EY-76-C-04-0656. 38p. Dep. NTIS, PC A03/MF A01.

Small quantities of tritium gas, tritium oxide and krypton-85 gas were released from the plant during the year. Average maximum ground level concentrations of these radioisotopes were all significantly less than 1/10 of 1 percent of the recommended guide for continuous nonoccupational exposure. Off-site releases of liquid effluents were analyzed for biochemical oxygen demand, suspended solids, fecal coliform bacteria, pH, nitrogen, phosphorus, arsenic, chlorides, chromium, copper, cyanides, detergents, fluorides, iron, lead, mercury, oil plus greases, phenols, turbidity and zinc. All results were well within permit limits. Analyses showed tritium oxide released in the effluent was of the average concentration was 0.2 percent of the nonoccupational exposure guide. Site perimeter and off-site air samples for tritium gas and tritium oxide, as well as off-site surface water samples obtained to distances of 9.6 kilometers (6 miles) from the plant site and analyzed for tritium content, showed levels significantly less than 1/10 of 1 percent of the recommended guide for continuous nonoccupational exposure.

38000 (LBL—7530) **Annual environmental monitoring report of the Lawrence Berkeley Laboratory, 1977.** Stephens, L.D. (ed.). (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Mar 1978. Contract W-7405-ENG-48. 36p. Dep. NTIS, PC A03/MF A01.

The data obtained from the Environmental Monitoring Program of the Lawrence Berkeley Laboratory for the Calendar year 1977 are described and general trends are discussed. The general trend of decreasing radiation levels at our site boundary due to accelerator operation during past years has leveled off during 1977 and in some areas shows a slight but not statistically significant increase as predicted in last year's summary. There were changes in both ion beams as well as current which have resulted in shifts in maxima at the monitoring stations. The gamma levels are once again reported as zero. There is only one period of detectable gamma radiation due to accelerator operation. The annual dose equivalent are reported from the environmental monitoring stations since they have been established. Radiation levels at the Olympus Gate Station have shown a steady decline since 1959 when estimates were first made. The Olympus Gate Station is in direct view of the Bevatron and most directly influenced by that accelerator. Over the past several years the atmospheric sampling program has, with the exception of occasional known releases, yielded data which are within the range of normal background. The surface water program always yields results within the range of normal background. As no substantial changes in the quantities of radionuclides used are anticipated, no changes are expected in these observations.

38001 (NLCO—1151) **Feed Materials Production Center environmental monitoring annual report for 1977.** Boback, M.W.; Ross, K.N.; Fuchs, D.A. (National Lead Co. of Ohio, Cincinnati (USA)). 1 Apr 1978. Contract EY-76-C-05-1156. 36p. Dep. NTIS, PC A02/MF A01.

This report contains environmental monitoring data collected at the Feed Materials Production Center during 1977. These data show that the average boundary concentrations of airborne radioactive contaminants from FMPC operations were no greater than 0.4% of the guide levels published in ERDA Manual Chapter 0524. The

resulting offsite radiation exposures would, therefore, be a small fraction of the standards for uncontrolled areas. Radionuclides in wastewater did not present a significant potential for radiation exposure. Concentrations of environmentally important nonradioactive contaminants in water and air are also reported. Results show that FMPC operations did not cause State standards for these contaminants to be exceeded.

38002 (ORNL-tr—4279) **General model for evaluating transport of radioactive products released to environment and its consequences.** Hladky, E.; Kubik, I.; Moravek, J. Translated by S.D. Blalock Jr. from *Bull. EGU;* **76**: 18-24(1971). 20p. Dep. NTIS, PC A02/MF A01.

A mathematical model is described for the evaluation of the transport and behavior of radioactive products released into the environment during the operation of nuclear power plants. It is based on the behavior of the products on the main protective barriers of nuclear power plants. A block diagram is presented of the model and the respective main programs are characterized.

THERMAL EFFLUENTS MONITORING AND TRANSPORT

38003 ADPIC: a three-dimensional particle-in-cell model for the dispersal of atmospheric pollutants and its comparison to regional tracer studies. Lange, R. (Lawrence Livermore Laboratory, University of California, Livermore 94550). *J. Appl. Meteorol.;* **17**: No. 3, 320-349(Mar 1978).

A hybrid Lagrangian-Eulerian atmospheric transport-diffusion model was developed to calculate the three-dimensional distribution of atmospheric pollutants in transient-region flow fields. This Atmospheric Diffusion Particle-in-Cell (ADPIC) code was validated against several existing closed-form analytical solutions including a puff release in steady, unidirectional shear flow, and a puff release with scale-dependent horizontal and vertical eddy diffusion coefficients. These tests showed that the ADPIC results were within a 5% error when compared to the analytic solutions. Regional (100 km) tracer studies at the National Reactor Test Station Idaho Falls, Idahok, and at the Savannah River Laboratory, Aiken, S. C., were also used to compare the code against field measurements.

SITE RESOURCE AND USE STUDIES

38004 MASCON-a mass consistent atmospheric flux model for regions with complex terrain. Dickerson, M.H. (Lawrence Livermore Laboratory, University of California, Livermore 94550). *J. Appl. Meteorol.;* **17**: No. 3, 241-253(Mar 1978).

MASCON was developed to provide air pollution models for the San Francisco Bay Area with mass consistent meteorological input data. Measurements of inversion base heights above topography and mean winds within the mixed layer calculated from surface observations of wind speed and direction were used as input data for the model. Variational calculus techniques were used to adjust the observed horizontal fluxes so they satisfied the continuity equation. In cases where air within the elevated inversion was entrained into the mixed layer, we used a parameterization of the vertical velocity. This model can also accept solid boundaries in the interior of the grid simulating conditions in the Bay Area where the base of the inversion is below some of the topographic features. This results in the horizontal flow fields being forced around these obstacles.

REGULATIONS

38005 Stability and analyses of nitric oxide in nitrogen. Robertson, D.J.; Groth, R.H.; Gardner, D.G.; Glastris, A.G. (Pratt and Whitney Aircraft Group, East Hartford, CT). *J. Air Pollut. Control Assoc.;* **27**: No. 8, 779-780(Aug 1977).

The paper reports the results of comparative analyses of three commercial cylinders of NO in N_2 and changes in analysis as a function of time of both these cylinders and the standard reference materials in steel cylinders. In addition to the two methods prescribed by the EPA, the commercial cylinders were analyzed by gas chromatography. The gas chromatographic method was of interest because of its ready availability in most laboratories and its usefulness for many other analyses of components normally measured in air pollution work. The SRM's available to our laboratory when the study was undertaken were limited to those with approximately 250 ppM to 1000 ppM NO in N_2.

38006 Environmental pollution control in metropolitan Athens. Gilad, A. (Environmental Pollution Control Project, Athens). *Ambio;* **6**: No. 6, 350-354(1977).

The Metropolis (in Greek: "Mother City") of Athens was a village of 10,000 inhabitants at a time when modern Greece became independent in 1827. Over the period of 150 years it grew into a busting urban conglomeration of three million people. This explosive rate of growth brought with it the inevitable environmental stresses and problems which exert a detrimental pressure on the quality of the life and which threaten the monuments of the ancient civilization in the area. The Environmental Pollution Control Project in the Metropolitan Area of Athens, which is a joint venture of the Greek Government, the United Nations Development Program and the World Health Organization, was established in 1973 to develop programs for preservation and improvement of environmental quality in Athens. This paper describes briefly the objectives, the methods of operation and the achievements of this Project in the areas of water and air pollution control, community noise abatement and solid waste management.

38007 Environmental management in a Mediterranean port city: Haifa. Evan, H.Z. (Advisor on Environment to the Mayor, Haifa). *Ambio;* **6**: No. 6, 346-349(1977).

Haifa is the center of an industrialized urban area characterized by rapid economic and urban growth. The metropolitan area is badly affected by pollution of its air, water and beaches, and by traffic congestion. In 1975 an experimental project was undertaken to develop methods of managing the area's environmental resources. The author discusses some administrative, jurisdictional, technical and economic problems encountered and describes the programs designed to manage air resources, reduce river and sea pollution, and prevent further degradation of the environment.

ENVIRONMENTAL SCIENCES, TERRESTRIAL

BASIC STUDIES

REFER ALSO TO CITATION(S) 36686, 36691, 37943, 38191

38008 (CONF-780129—2) **Data base on avian mortality on man-made structures.** Dailey, N.S. (Oak Ridge National Lab., Tenn. (USA)). 1978. Contract W-7405-ENG-26. 12p. Dep. NTIS, PC A02/MF A01.

From U.S. Fish and Wildlife Service workshop; Oak Ridge, TN, USA (Jan 1978).

A computerized data base concerning avian mortality on man-made structures is available for searching at the Ecological Sciences Information Center of the Information Center Complex, Information Division, Oak Ridge National Laboratory. This data base, which contains entries from the available literature, provides information on avian mortality from either collision into or electrocution on man-made structures. Primary emphasis has been placed on avian collision with obstacles such as television and radio towers, airport ceilometers, transmission lines, and cooling towers. Other structures included in the studies are fences, glass walls and windows, lighthouses, telegraph and telephone wires, buildings, monuments, smokestacks, and water towers.

38009 (CONF-7510172—P1, pp 351-358) **Application of remote sensing data to geographic-based information management systems.** Halpern, J.A.; Alexander, L.D.; O'Regan, D.M. (Dames and Moore, Cranford, NJ). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

Remote sensing data are applied to a data management system for a preliminary power plant siting investigation. A siting survey was performed for location of a large power plant facility on the Delmarva Peninsula (Delaware, Maryland, Virginia). The final output of the system is a decision map that reflects all the technical and arbitrary decisions and weights that went into the combining of source data maps. The geologic linear map was constructed by photogeologic interpretation of black-and-white LANDSAT frames in bands 5 and 7 at a scale of 1:500,000. The vegetation map, the land use map, and surface water map were all derived by supervised multispectral processing of digital LANDSAT data. (HLW)

38010 (CONF-7510172—P1, pp 359-368) **Utilization of high altitude photography and LANDSAT-1 data for change detection and sensitive area analysis.** DeGloria, S.D.; Daus, S.J.; Tosta, N.; Bonner, K. (Univ. of California, Berkeley). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

A multi-disciplinary and multi-purpose remote sensing study was conducted in the northern desert shrub environment to evaluate the applicability of remotely-sensed data as an input to the Bureau of Land Management (BLM) Planning System, and to provide map products and data summaries to be utilized by District-level land managers. The experimental design, procedures, and results of the environmental monitoring tasks of that study are reported. Sensitive areas were mapped and monitored within and between two seasons utilizing both manual and automatic analyses of high-altitude CIR photography and LANDSAT-1 data. Photographic illustrations, photo and base map overlays, and digital output were generated for a 500,000 nectare region in northeastern California and northwestern Nevada.

38011 (CONF-7510172—P1, pp 369-372) **Collection and processing of remote sensing data related to wildlife conservation in natural environments.** Nichol, J.E. (Univ. of Aston, Birmingham, Eng.). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

A discussion is presented of the collection, processing, and evaluation of remote sensing data related to wildlife habitats in the Gairloch Conservation Unit, Wester Ross, Scotland by both manual and machine-assisted methods. To obtain a more objective measure of terrain diversity both within and between habitats, a scanning microdensitometer was used. The initial survey using the panchromatic photography provided ground truth information and values were calculated for areas corresponding to each of 38 frames selected. Scanning data were correlated with scores for the areas of frames evaluated according to intra-habitat variables. (HLW)

38012 (CONF-7510172—P1, pp 511-520) **Finland's approach to remote sensing oriented earth resources surveys.** Jaakkola, S.; Kilpela, E. (Technical Research Center of Finland, Espoo). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

In the beginning of 1974, a three-year Earth Resources Remote Sensing Project was initiated at the Laboratory of Land Use, Technical Research Center of Finland. The ultimate objective of the project is to develop automated environment monitoring and resource inventory methods capable to meet Finnish needs and conditions. On the basis of various promising preliminary results obtained by modern remote sensing techniques, especially in the USA, it seems justified and necessary to perform closer analyses on the practical uses of those techniques. This requirement rises, in Finland, particularly from the fields of forestry, geology and hydrology. These are the three branches involved in laboratory's multidisciplinary R and D-effort. The project is financially supported by various state and private organizations engaged in above fields. In addition to digital satellite data, the project also operates with digital aircraft scanner data. The approach to data processing is largely software-oriented.

38013 (CONF-7510172—P1, pp 521-522) **National program of remote sensing in France.** Alouges, A. (Centre National d'Etudes Spatiales, Toulouse). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

The Groupement pour le Developpement de la Teledetection Aerospatiale (G.D.T.A.) is charged with developing the methods of remote sensing and promoting their usage. The G.D.T.A. organizes aircraft flights or stratospheric balloons equipped with varied capturing devices and delivers the results to several scientific investigators for examination and interpretation. Data are collected from Marseille to the natural reserve of the Rhone delta, passing through industrial zones, zones of intensive cultivation, areas with small tracts of land, and noncultivated regions. (HLW)

38014 (CONF-7510172—P1, pp 523-532) **First approach to realizing a German earth research program.** Wahl, M.; Flasche, A. (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Cologne). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

The main goal of a German earth research program is to assure qualified participation of the FRG in future worldwide earth observation systems. At the time being, the main national efforts concentrate on preparing and carrying out two complementary programs: The earth research airborne measurement program with the main activities in developing hard- and software systems for data preprocessing and data analysis and interpretation. Within the Spacelab utilization program, specific sensor systems suitable for earth observation and meteorology are in the initial phase of development.

38015 (CONF-7510172—P1, pp 545-548) **Remote sensing in the Netherlands.** Eckhart, D.; Geerders, P. (NIWARS, Delft, Netherlands). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

Remote sensing activities are concerned with problems such as the radiation balance of the earth, monitoring on a global scale of oceans and atmosphere, mapping resources such as biomass and soils, and regional problems determined by climate, geology, and vegetation. Research programs are discussed with regard to the following: international cooperation; remote sensing hardware support; remote sensing education; water quality; agriculture; geology; and activities of the Netherlands Interdepartmental Working Community for the Application of RS techniques. (HLW)

38016 (CONF-7510172—P1, pp 549-554) **Some remote sensing activities in Spain: a computer approach.** Aguilar, R. (Univ. Autonoma, Madrid); Nunez de las Cuevas, R.; Picon, J.L. 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

A description of the computer approaches to some sensing activities currently pursued in Spain is presented here. The activities are part of a cooperative effort recently initiated to investigate LANDSAT data applications to different research problems. Several disciplines are involved in this effort: geology, podology, botany, geography and hydrology. Spain's central region has been chosen as a test site. The geology programme aims at confirming and competing current knowledge of geological structures in the test site studying less explored zones. Different spatial filters are being used for this purpose. A soil survey study is being performed as part of the podology programme by means of automatic classification algorithms already available. Previous work on this provides the necessary amount of ground truth. Urban growth in the city of Madrid and its periphery is also being investigated. Urban changes are detected by a combination of supervised and unsupervised classifiers and registration techniques. The coverage of deciduous and nondeciduous forests is being studied within the botany programme. A number of techniques is being experimented on to solve the serious difficulties encountered due to the terrain's orography. Finally, different algorithms are being evaluated to increase the accuracy of water area mensuration within an effort to establish a means to assess water resources of Spain's central region.

38017 (CONF-7510172—P1, pp 563-570) **Applications of remote sensing in Switzerland.** Haefner, H. (Univ., Zurich); Itten, K.; Schanda, E.; Winiger, M.; Seidel, K. 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

Major applications of remote sensing techniques in Switzerland and the development of its interpretation methodology are reviewed briefly for the following sensing and imaging systems: conventional black and white photography and orthophotographs; color and IR color photography; multispectral scanners; thermal infrared; and passive microwaves.

38018 (PNL—2299) **Hanford National Environmental Research Park (NERP): a descriptive summary of the site and site-related research programs, 1952—1977.** Vaughan, B.E.; Rickard, W.H. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Nov 1977. Contract EY-76-C-06-1830. 43p. Dep. NTIS, PC A03/MF A01.

The Hanford National Environmental Research Park site is described in general terms and major plant communities and special habitats are discussed. Important bird, mammal, and fish populations are listed. Current research programs on aquatic and terrestrial ecosystems and radioecology are reviewed briefly. A list is included of some 100 publications that report results of research studies in detail.

38019 (PNL—2465) **Darkling beetle populations (Tenebrionidae) of the Hanford site in southcentral Washington.** Rogers, L.E.; Woodley, N.; Sheldon, J.K.; Uresk, V.A. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Feb 1978. Contract EY-76-C-06-1830. 129p. Dep. NTIS, PC A07/MF A01.

This 3-yr study documents the taxonomic composition, relative abundance, and seasonal distribution of darkling beetles occupying the Hanford Site in southcentral Washington. A taxonomic key and species diagnosis are provided to assist in identification by the nonspecialist. Analysis of food plant availability and selection serves to identify transfer pathways through beetle populations and permits construction of food web diagrams depicting the flow of materials through the darkling beetle component.

38020 Reworked middle Wisconsinan plant fossils from the Brampton esker, southern Ontario. Karrow, P.F. (Univ. of Waterloo, Ont.); Harrison, W.; Saunderson, H.C. *Can. J. Earth Sci.;* **14**: No. 3, 426-430(Mar 1977).

Plant fossils, consisting of abraded pieces of wood, seeds, and pollen, occur near the bottom of the Armbro gravel pit in a till-capped esker near Brampton, Ontario. A radiocarbon date suggests a Mid-Wisconsinan age for the wood, whereas stratigraphic evidence suggests a Port Huron age for the enclosing sediments. The plant fossils indicate conditions similar to those now found in the southern boreal forest. Derivation of the plants from buried Middle Wisconsin interstadial sediments to the southeast is suggested. Plant remains in glacial deposits should normally be assumed to be reworked; radiocarbon dates on such fossils do not date the enclosing sediment.

38021 Field water balance and simulated water relations of prairie and oak-hickory vegetation on deciduous forest soils. Luxmoore, R.J.; Van Rooyen, D.J.; Hole, F.D.; Mankin, J.B.; Goldstein, R.A. (Oak Ridge National Lab., TN). *Soil Sci.;* **123**: No. 2, 77-84(Feb 1977).

A steady-state model of atmosphere-soil-plant water relations, implementing both the combined energy balance, aerodynamic calculation of evapotranspiration, and a five-layer Darcy soil-water flow system, was used to simulate on a daily basis the water status and budget of experimental plots with either prairie grass or oak forest vegetation. A field water balance study provided independent estimates of evapotranspiration and drainage, based on measurements of soil water at several depths during the growing season. Oak forest and prairie grass vegetation in southern Wisconsin showed an average evapotranspiration rate of 2.0 $cm^3\ cm^{-2}\ week^{-1}$ from mid-June to early October based on a water balance of the top 180 cm of soil. Simulation results were in close agreement with the field estimates, although differences in time distribution were shown, particularly for the prairie grass plots. Actual evapotranspiration would be greater than these results due to soil water uptake at depths below 180 cm. Soil water drainage was negligible during most of the growing season for vegetated plots whereas drainage from treatments without vegetation was slightly less than the precipitation received. Soil water content was generally lower on vegetated plots than on nonvegetated plots during the growing season. The model provided a means of evaluating some phenomena not measured in the field experiments. Simulations suggested that the oak vegetation was under water stress on more days during the growing season than the prairie grass.

38022 Physical properties of fly ash-amended soils. Chang, A.C.; Lund, L.J.; Page, A.L.; Warneke, J.E. (Univ. of California, Riverside). *J. Environ. Qual.;* **6**: No. 3, 267-270(1977).

Fly ash from a coal-fired power generating plant was mixed with five California soils at rates of 0, 2.5, 5.0, 10.0, 25.0, and 50.0% by volume. The physical properties related to the agronomic use of fly ash-amended soils were characterized by determining water-holding capacity, bulk density, hydraulic conductivity, and modulus of rupture on laboratory compacted soil cores. The moisture release characteristics of each mixture were also determined. Results indicated that a small amount of fly ash added to soils does appear to affect some measured physical properties of soils. At application rates >25%, there was a consistent increase in water-holding capacity (except a Domino loam soil), and a decrease in bulk density and modulus of rupture in all soils tested. The hydraulic conductivity increased with small amounts of fly ash, but declined rapidly as fly ash volume increased. Although fly ash application increased the water-holding capacity of soils, the amount of water available to the plant did not change significantly. At a low applicant rate, fly ash amendment appaared useful in improving certain agronomic properties of soils.

38023 Adsorption of copper, zinc, and cadmium by a forest soil. Sidle, R.C.; Kardos, L.T. (Pennsylvania State Univ., University Park). *J. Environ. Qual.;* **6**: No. 3, 313-317(1977).

Time-dependent batch equilibrium studies for Cu, Zn, and Cd were conducted to determine the sorbing properties for these metals on the upper 30 cm of a forest soil. Major cations were added to equilibrating solutions in an attempt to match to cationic matrix of a sewage sludge. Essentially all of the Cu was adsorbed by the soil in the first 0.3 hour of equilibration. Copper adsorption data fit the Freundlich isotherm better than the Langmuir isotherm. Adsorption of Zn and Cd was more time dependent than Cu, especially for the 0 to 7.5 cm depth of soil, and was described with some success by the empirical kinetic equation, delta S/delta t = aC/sup b/S/sup c/, where S is μg metal absorbed per g soil, C is concentration of metal in final equilibrating solution, t is time, and a, b, and c are constants. Batch data taken at 3 hours of equilibration for Zn and Cd also fit the Freundlich isotherm better than the Langmuir isotherm. For Cu, Zn, and Cd adsorption, Freundlich constants (K) were higher for the 0 to 7.5 cm depth than for the 7.5 to 15 cm depth, indicating the binding effects of the higher level of organic matter in the surface 7.5 cm of forest soil.

38024 (ORNL-tr—4562) **Glassy death: the menace of glass walls to the bird population.** Keil, W. Translated by R.G. Mansfield from *Vogel-Kosmos;* 8: 184-186(1964). 4p. Dep. NTIS, PC A02/MF A01.

Modern architecture makes use of glass in some manner and form whenever a place can be found for it. Such glass walls or windowpanes, however, represent a serious source of danger to birds. If the relevant literature is reviewed, we find again and again, just in recent years, articles dealing with this problem. The most dangerous bird traps in this connection are probably glassed-in connecting passageways between two parts of a building. Possible remedial actions are discussed.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 36808, 36811, 36814, 36815, 36816, 36822, 36825, 36826, 36856, 38023, 38083

38025 Lead-containing particles on urban leaf surfaces. Koslow, E.E.; Smith, W.H.; Staskawicz, B.J. (Yale Univ., New Haven). *Environ. Sci. Technol.;* **11**: No. 10, 1019-1020(Oct 1977).

London plane tree [Platanus acerifolia (Ait.) Willd.] leaf samples collected from an urban environment were examined with an electron microanalyzer and electron microscope equipped with an energy-dispersive x-ray analyzer. Lead-containing aerosol particles found upon these leaves contained no detectable chlorine or bromine. The lead appeared to be associated with sulfur and phosphorus in the form of lead sulfate and lead orthophosphate.

38026 Subsurface persistence of crude oil spilled on land and its transport in groundwater. Duffy, J.J. (Univ. of Calgary, Alberta); Mohtadi, M.F.; Peake, E. pp 475-478 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

The persistence of water-soluble hydrocarbons from crude oil spills on land was investigated as a source of groundwater contamination by means of theoretical models, percolation experiments, and the analysis of core samples from spill sites. Examination of a one-dimensional flow model of convection, dispersion, biodegradation, and adsorption of an oil-water solution beneath a water table revealed that under certain conditions adsorption has no effect on the maximum oil concentration reached at any given distance from a spill. Chemical analysis of water percolated through an oil spill zone in a sand trough and also through soil cores taken at spill sites revealed that it may take the equivalent of much more than 100 times the average annual rainfall of Calgary to diminish the water-soluble components in the leachate to a level acceptable in drinking water. Measurements of the amount of alkanes and isoprenoids as functions of depth in field cores at spill sites of various ages and locations indicated that biodegradation rates are much lower in the anaerobic zone than above. Theoretical predictions indicate that contaminated groundwater may extend in the direction of flow from less than one meter to several thousand meters from a spill depending primarily on biodegradation rates and pore velocities. It is concluded that oil in the subsoil resulting from spills on land has the potential to pose very long-term threats to groundwater quality and, by the mechanism of resurfacing, to vegetation.

38027 Fate of petroleum in a soil environment. Cresswell, L.W. (Continental Oil Co., Ponca City, OK). pp 479-482 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

Information generated from Conoco studies of waste oil biodegradation in the soil environment could have direct application in the clean up of residual oil left after an accidental spill. The studies, which included the tilling of oil into the upper 6-8 in. of topsoil followed by addition of commercial fertilizer as nutrients, resulted in oil degradation of up to 56% after 41 months of exposure for initial oil concentration in the soil of 4%—8%. Annual degrada-

tion rates of 7-16 gm oil/kg soil found in these studies for a soil environment compare favorably with those rates for biodegradation studies found in the literature using shake flask systems. No adverse environmental effects have resulted to date from the oil-in-soil biodegradation studies. The oil appears to stay bound tightly in the layer of soil where it was originally applied, and healthy appearing crops of wheat have been grown in the oil soil plots.

38028 Flax pond ecosystem study: exchanges of phosphorus between a salt marsh and the coastal waters of Long Island Sound. Woodwell, G.M. (Marine Biological Lab., Woods Hole, MA); Whitney, D.E. *Mar. Biol.;* **41**: No. 1, 1-6(1977).

The exchanges of phosphorus between the Flax Pond, a tidal Spartina alterniflora marsh on the north shore of Long Island (USA) and Long Island Sound were measured over 18 months. Phosphate was exported from the marsh from May through December and imported during the remainder of the year. Organic phosphorus appears to be accumulated in all seasons, but the yearly phosphorus budget of the marsh is approximately balanced despite the accumulation of about 6 mm of sediment annually.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 37939, 37996, 37998, 38000, 38018

38029 (UCLA—12-1135) **Soil, plant, food chain relationships of the transuranium elements: selected annotated bibliography.** Wallace, A.; Romney, E.M.; Kinnear, J.E. (California Univ., Los Angeles (USA). Lab. of Nuclear Medicine and Radiation Biology). Oct 1977. 38p. NTIS.

Approximately 250 references to the literature on food chain relationships of the transuranium elements are presented in this annotated bibliography. (HLW)

38030 (ORNL-tr—4596) **Migration of plutonium in natural soils.** Jakubick, A.T. (Kernforschungszentrum Karlsruhe (Germany, F.R.)). Dec 1976. Translation by S.D. Blalock Jr. from pp 217-224 of KFK—2380. 6p. Dep. NTIS, PC A02/MF A01.

Publications were evaluated for data needed for development of mathematical models describing movement of fallout plutonium from the air to the earth. Quantitative data for plutonium distribution in sandy loam near New York City were used to estimate migration of fallout plutonium. Equations are presented to show results of the study. (HLW)

SOIL

REFER ALSO TO CITATION(S) 36990, 37007, 37756

38031 Preparative-scale size fractionation of soils nd sediments and an application to studies of plutonium geochemistry. Muller, R.N.; Tisue, G.T. (Argonne National Lab., IL). *Soil Sci.;* **124**: No. 4, 191-198(Oct 1977).

A modified elutriation procedure is described for the physical separation of soils and sediments based on particle size. The size distribution of fractions obtained by this method is directly verified and indicates that acceptable separation of silts and clays may be obtained. Studies of plutonium distribution with particle size indicate that the greatest concentrations are in the smaller size classes, which are most subject to erosional transport.

38032 Effect of selective dissolution, electrolytes, aeration, and sterilization on technetium-99 sorption by soils. Landa, E.R.; Thorvig, L.H.; Gast, R.G. (Univ. of Minnesota, St. Paul). *J. Environ. Qual.;* **6**: No. 2, 181-187(1977).

The objective of this study was to determine the extent that technetium 99, a long-lived beta-emitting radionuclide, might be sorbed from aqueous solution by 11 well-characterized soils, and to elucidate the sorption mechanisms involved. About 98% of the added ^{99}Tc was sorbed within a period of 2 to 5 weeks by 8 of the 11 soils. The slow kinetics observed and the removal of trace quantities of ^{99}Tc from solution in the presence of large amounts of chloride and phosphate tend to rule out anion exchange as the sorption mechanism. The lack of sorption exhibited by the low organic matter soils, the reduction in sorption following H_2O_2 digestion of the soil, and the high recoveries of sorbed ^{99}Tc on extraction with NaOH suggest a role for the living and/or nonliving organic fraction of the soil. Sterilization of previously sorbing soils eliminated the sorption ability, indicating a microbial role in the process. Results of aeration experiments were ambiguous but suggest that anaerobic conditions are not a prerequisite for ^{99}Tc sorption by soils.

38033 Aerial deposition of plutonium in mixed forest stands from nuclear fuel reprocessing. Adriano, D.C.; Pinder, J.E. III. (Savannah River Ecology Lab., Aiken, SC). *J. Environ. Qual.;* **6**: No. 3, 303-306(1977).

Concentrations of ^{238}Pu and ^{239,240}Pu were determined in bark, organic matter, and soil samples collected in the summer of 1975 from pine (Pinus taeda) and hardwood (Quercus falcata; Carya tormentosa) stands near a nuclear fuel reprocessing plant at the U.S. Energy Res. and Dev. Admin.'s Savannah River Plant near Aiken, S.C. The results indicated that tree crowns intercepted fallout Pu (Pu-bearing particles) and produced higher Pu concentrations in the organic matter and soil under tree crowns. Higher ^{239,240}Pu concentrations were found under pines than under hardwoods. Plutonium concentrations in the O1 (litter, A_{00}) and O2 (organic matter, A_0) layers were higher than those in mineral soil, but most of the Pu was contained in the mineral soil. Higher contents of ^{239,240}Pu were observed near the tree stems than in locations outside of the tree crowns. In pines these values were 163 and 80 nCi ^{239,240}Pu/m_2, and in hardwoods, 122 and 80 nCi ^{239,240}Pu/m_2, for the respective locations, from the litter to the 15-cm depth. The proportion of ^{238}Pu contained in foliage, litter, and organic matter was greater than for ^{239,240}Pu. However, the latter radionuclides had a greater proportion contained in the mineral soil. This observation is consistent with the more recent releases containing a higher percentage of ^{238}Pu from reprocessing operation. Plutonium concentrations in the 5 to 15 cm depth indicated limited Pu mobility in soil, but ^{238,240}Pu concentrations at this depth were higher near tree stems, suggesting greater mobility perhaps as a result of stem flow.

TERRESTRIAL ECOSYSTEMS AND FOOD CHAINS

REFER ALSO TO CITATION(S) 38033

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 36673, 36674, 36676, 36677, 36678, 36679, 36680, 36681, 36682, 36683, 36684, 36685, 36686, 36687, 36689, 36690, 36691, 36692, 36693, 36694, 36695, 36698, 36704, 36706, 37513, 37518, 38009, 38010, 38065

38034 (CONF-7510172—P1, pp 345-350) **Evaluation of land use and its color representation in Tokyo Districts with LANDSAT digital data.** Murai, S. (Univ. of Tokyo, Minatoku, Japan). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

A pixel of LANDSAT digital data with an area of 57 meters by 76 meters contains composite reflections from several different land uses in an overpopulated city as Tokyo Districts. A conventional map of land use has been represented in different colors, corresponding to the nominal land use. For example, industrial zone is painted in blue, without being discriminated between buildings and open spaces near those buildings. However, remotely sensed data show quite different values between those buildings and open spaces. In addition, a paddy field should be painted in yellow in the map of land use as "land to be used as paddy field", regardless of the seasonal variation. Remotely sensed data should be classified into categories which represent the real status of land use or land cover at the time of flight. As it is not appropriate to assign a pixel of unresolved remotely sensed data to a name of land use, a new criterion for classification of real status of land use will be required to be established. In this study, land use is assumed to be composed of a mixture of three primary components, water, vegetation and non organic matter (bare soil, rock, sand, concrete, asphalt and so on). Three components can be evaluated by the remotely sensed data because of their unique spectral characterisities. Three primary components, water, vegetation and non organic matter are corresponded to three primary colors, blue, green, and red respectively. The real status of land use or land cover with a mixture of water, vegetation and non organic matter will be represented in a mixture of three primary colors, based upon the criterion of color index, which provides meaning to a mixture of land use.

38035 (CONF-7510172—P1, pp 373-382) **LANDSAT investigations of recent urban land use changes in Northeast China.** Welch, R.; Pannell, C.W. (Univ. of Georgia, Athens). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

Information on land use changes in four Chinese cities, Shenyang, Anshan, Fushun and Changchun, for the period 1945 to 1973, was obtained by comparing LANDSAT images with maps and aerial photographs produced at the end of World War II. Both visual interpretation of images and machine processing of computer compatible tapes were employed to analyze the LANDSAT data. Of

the two techniques, the visual approach was considered to be superior in terms of accuracy, time and cost. Comparative studies of available data indicate all cities underwent extensive growth and change during the study period. The predominant pattern of growth and change seems to involve a shift from the functionally distinct urban sectors originally developed by the Japanese to a mixture of housing estates, administrative buildings and industrial sites. These changes are thought to be consistent with contemporary Chinese planning policies of creating self-contained urban communities.

38036 (CONF-7510172—P1, pp 383-392) **National land use survey of the developed areas of England and Wales by remote sensing.** van Genderen, J.L. (Fairey Surveys Ltd., Maidenhead, Eng.); Smith, T.F. 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

The Secretary of State for the Environment in the United Kingdom has commissioned a project to map all the developed areas of England and Wales by means of remote sensing. The contract was awarded to Fairey Surveys Limited's "Environment and Resources Consultancy". This national land use survey of developed land is being carried out at a scale of 1:50,000 on transparent map overlays using the latest Ordnance Survey Sheets at the same scale, and with constant reference to Royal Air Force panchromatic small scale aerial photography flown in 1969. The survey, which will be completed within twelve months of commencement, will result in the compilation of a series of over 120 land use maps to cover the whole of England and Wales. The Department of the Environment intends then to computerize the handling of the mapped information, especially for measurement purposes and in order to relate it to Census information. The final maps, together with the statistical data derived from them, will form an important base line against which to monitor subsequent changes in the nature, extent, and distribution of the developed areas of England and Wales by means of remote sensing techniques.

38037 (CONF-7510172—P1, pp 393-400) **Testing low cost interpretation systems for updating land use inventories.** Hardy, E.E.; Hunt, L.E. (Cornell Univ., Ithaca, NY). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

The design characteristics of land use inventories should include the capability to repeat the production of information over periods of time. The New York State Land Use and Natural Resource Inventory (LUNR) was designed with that capability built in. Although it has been seven years since the basic data was accumulated, it is still widely used. The need for updating the inventory is obvious, however, and steps are in progress to do so. Three studies have been undertaken that identify the importance of re-acquisition of data and its analysis. The first was a roadside survey of a county where the change in land use was found to be 30 percent five years after the inventory. The second was a re-survey of seven counties, where new LUNR data was acquired and changes analyzed on the basis of square kilometer cells, on a cell by cell basis. The third study was designed to test the feasibility of approaches to developing the re-survey techniques for the LUNR type of inventory. Processes tested include: use of the zoom stereoscope, use of orthophoto base maps, use of high altitude imagery, color photography, and regular black and white photography. Microfiche readers also have been adapted to this work. The most efficient systems will be reported, with current results showing the microfiche reader, using high altitude monoptical coverage, as the most efficient and most accurate techniques for interpretation. Large areas have been inventoried with field check records indicating 98 percent to 100 percent accuracy in the classification decision process. Cost evaluation will be considered in detail, to determine the cost effectiveness of the selected methods. The significance of this research is of major importance, for it indicates an extremely low cost interpretation approach, using high altitude color photography, which could produce a very complex comprehensive inventory at very low cost.

REGULATIONS

REFER ALSO TO CITATION(S) 36690, 36839, 38006, 38007

ENVIRONMENTAL SCIENCES,

AQUATIC

BASIC STUDIES

REFER ALSO TO CITATION(S) 36714, 38013, 38015, 38016, 38018, 38251

38038 (ANL/ES—62) **Validation and software documentation of the ANL fish-impingement model.** Murarka, I.P.; Bodeau, D.J.; Derickson, W.K. (Argonne National Lab., Ill. (USA)). Apr 1978. Contract W-31-109-ENG-38. 126p. Dep. NTIS, PC A07/MF A01.

Portions of document are illegible.

This report contains the results of a validation test of the ANL Fish Impingement Model. By the use of 1974 fish-impingement and environmental data from the Zion Nuclear Power Station, it is shown that the modified and expanded mathematical model yields reasonably good results in calculations of daily fish-impingement losses at the cooling water intakes. Comparisons confirmed that the fish-impingement process depends primarily on the abundance of fish in the vicinity of a cooling water intake, whereas the probability function gives the susceptibility to impingement provided that fish are present in the intensity region. In view of the limited amount of information available with regard to the various environmental and fish-abundance factors, it appears that the present form of the model is adequate and that efforts to refine the model further are not warranted.

38039 (CONF-7510172—P1, pp 411-420) **Investigation of the waters in the lower Chesapeake Bay area.** Bowker, D.E. (National Aeronautics and Space Administration, Hampton, VA); Witte, W.G.; Fleischer, P.; Golsink, T.A.; Hanna, W.J.; Ludwick, J.C. 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

Since October of 1972 the Langley Research Center and the Old Dominion University have been engaged in a cooperative effort to investigate the waters of the lower Chesapeake Bay area. During the first year an intensive effort was made to collect water data at the time of LANDSAT-1 overpasses. Bands (5 and 6) of the MSS were shown to be useful for monitoring total particles, although a daily calibration was required. Band 5 had a high correlation with sediment and under some conditions an internal correction for atmospheric interference was possible. The relation of sediment to particles was established by using the MSS radiance values, since the two parameters were not monitored at the same stations. A contouring program was developed to display the sediment variation in the lower Bay at the time of the January 26, 1973, overpass. Attenuation coefficients monitored continuously by ship along three baselines were cross correlated with radiance values on 3 days. Evidence for tidal effects was obtained by showing that correlations improved when ship data collected during the nearest "tidal time" instead of physical time were used.

38040 (CONF-7510172—P1, pp 421-435) **Skylab MSS vs. photography for estuarine water color classification.** Gordon, H.H.: Nichols, M.M. (Virginia Inst. of Marine Science, Gloucester Point, VA). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

A computer classification is performed on data from the Skylab multispectral scanner (S192) and Earth Terrain Camera (S190 B) for the Rappahannock Estuary in the Chesapeake Bay. A comparison of results indicates a similar water class structure from color film and MSS tapes, but a much better two dimensional chart derived from the MSS.

38041 (CONF-7510172—P1, pp 437-446) **Application of LANDSAT to the surveillance and control of eutrophication in Saginaw Bay.** Rogers, R.H. (Bendix Aerospace Systems Div., Ann Arbor, MI); Shah, N.J.; McKeon, J.B.; Wilson, C.; Reed, L.; Smith, V.E.; Thomas, N.A. 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

Computer techniques developed for mapping water quality parameters from LANDSAT data are demonstrated, using ground truth collected in an ongoing survey of water quality in Saginaw Bay (Lake Huron), Michigan sponsored by the US Environmental Protection Agency. Chemical and biological parameters were collected at 27 bay stations in concert with LANDSAT overflights.

Application of stepwise linear regression to 12 of these parameters and corresponding LANDSAT measurements resulted in relationships that can be applied to map any one of the 12 water quality parameters over the entire bay. The regression correlation coefficients varied from 0.99 for total phosphorus to 0.72 for chlorophyll a corrected. Five of the water quality parameters are best correlated with LANDSAT Band 6 alone. One parameter, temperature, relates to Band 5 alone and only two bands are justified for mapping the remaining six parameters.

38042 (CONF-7510172—P1, pp 447-460) **Water quality indicators obtainable from aircraft and LANDSAT images and their use in classifying lakes.** Scherz, J.P. (Univ. of Wisconsin, Madison); Van Domelen, J.F. 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

For remote sensing of water quality when distilled water and a very clear, deep lake approaching distilled water are used as laboratory and field reflectance standards, it is possible to eliminate surface reflection and atmospheric effects. For other target lakes, the resulting residual radiance is due only to the material added to the pure water of these lakes. This material is what impairs water quality. The relative strength of the residual radiance at different wavelengths can be used to determine the type of material. The absolute strength of the radiance can be used to determine its concentration. If physical interactions are understood, these techniques can be used with laboratory, boat or satellite data.

38043 (CONF-7510172—P1, pp 461-470) **Skylab analysis of San Francisco Bay.** Steller, D.D. (ESCA-Tech Corp., Long Beach, CA); Pirie, D.M. 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

Sediment transport and deposition characteristics in San Francisco Bay are of utmost importance to shipping, channel clearing operations, and shoreline construction. Analysis of satellite imagery from SKYLAB overflights reveals detailed information that is being applied to basic planning and operational decisions concerning the Bay area. Variations in sediment transport is observable where the fresh water Sacramento-San Joaquin River inflow is modified by the dynamic tidal and current activity in San Francisco Bay. The S-190A multispectral photographic imagery and S-190B Earth Terrain camera imagery was utilized in mapping distribution patterns. Changes in temperature, dissolved oxygen, Ph, salinity and pollutants information simultaneously collected was correlated with the spectral differences observed in the various SKYLAB data. The thermal band on the SKYLAB multispectral scanner (S-192) computer tape data was utilized in differentiating surface temperatures. Color enhanced false color pictures of density-stretched S-192 data was correlated with the color photographic and multispectral photography resulting in sediment distribution maps of the Bay surface. The planning for dredging near previously constructed structures, dredging of shipping channels, and the possible result of new shoreline construction on sediment deposition are areas in which the SKYLAB interpretations were applied. With deeper draft vessels needing deeper channels, the ever-increasing expensive dredging operations must be utilized at maximum efficiency. In the planning of shoreline construction the determination of present sediment transport patterns and the effects of modifying such patterns must be thoroughly considered. SKYLAB imagery allows the investigator to determine the dynamic patterns that are the result of natural as well as man-made modifications in the Bay surface and near-surface waters. The most useful SKYLAB sensor film was the S-190B color photography.

38044 (CONF-7510172—P1, pp 471-476) **Past and future remote sensing at Newcastle University, Australia.** Ellyett, C.D.; Goldsbrough, P.F.; McLauchlan, E.C.; Pratt, D. (Univ. of Colorado, Boulder). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

A Daedalus airborne infrared linescan unit, operating principally in the 8 to 14 μm region, has been used by the University of Newcastle, N.S.W. Australia, for the past five years. Apart from conventional imagery, data are now being converted to digital format and computer processed to give thermal contours. These can be superposed on aerial photographs. Most work to date has been associated with water quality. A project is due to start in 1976 integrating airborne data with meteorological test site results to provide estimates of evapotranspiration over a complete annual cycle. The work will also serve as a basis to determine whether the data from the NASA Heat Capacity Mapping Satellite, due to be launched in late 1977, can be used to measure evapotranspiration over large areas.

38045 (CONF-7510172—P1, pp 477-484) **Completely airborne calibration of aerial infrared water-temperature measurements.** Schott, J.R. (Calspan Corp., Buffalo); Tourin, R.H. 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

A completely airborne method to calibrate aerial infrared mapping of water temperature was developed. This technique utilizes infrared radiometer data collected on a series of passes at different altitudes over a target area to calibrate the radiometer for absolute temperature at zero altitude, without the need for ground-based measurements. The radiometer data are, in turn, used to calibrate an aerial infrared thermal mapper, which scans the water surface viewed in a series of line scans over a 120° view angle perpendicular to the direction of airplane travel. The airborne calibration method was applied to 75 infrared images of 31 power plant discharges in New York State. Surface temperature measurements made simultaneously with the overflights were subsequently compared to the results of the aerial infrared mapping. The surface and aerial measurements agreed well, usually within 1°F.

38046 (CONF-7510172—P1, pp 485-494) **Use of remote sensing for water resource management in Michigan.** Christensen, R.J. (Michigan Dept. of Natural Resources, Lansing); Wezernak, C.T. 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

The operational use of remote sensing by the Michigan Water Resources Commission is discussed. The applications considered included power plant discharges and industrial discharges. Applications are examined in terms of using spectral bands in the thermal IR, visible, and ultraviolet. The results indicate that remote sensing can serve as an important addition to techniques available to a regulatory agency for environmental monitoring.

38047 (CONF-7510172—P1, pp 495-503) **Remote sensing of wetlands in Virginia.** Penney, M.E.; Gordon, H.H. (Virginia Inst. of Marine Science, Gloucester Point). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

The study is oriented toward the environmental management details of wetlands and reports technical details involving the use of ERTS data with LARS analysis for inventorying wetlands and low altitude film imagery analysis for determining plant community parameters. Standard IBM subroutines were used to perform multiple regressions on plant sample dry weight, average height, and sample stem density with film density, polar view angle, and azimuthal view angle. Correlations were very low and not usable for predicting new values for dry weight. (HLW)

38048 (CONF-7510172—P1, pp 585-594) **Thematic mapping of coral reefs using LANDSAT data.** Smith, V.E. (Cranbrook Inst. of Science, Bloomfield Hills, MI); Rogers, R.H.; Reed, L.E. 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

Recent progress is reported in a continuing study of coral reef monitoring by satellite. Physiographic zones of the Australian Great Barrier Reef (Cape Melville area) were categorized and mapped by automated processing of LANDSAT (ERTS) tapes. Data products included color-coded, geometrically-correct images (1:250,000 scale) and quantitative inventories of zonal area on selected reefs. Categorized images were evaluated with reference to aerial photography. These results further demonstrate the potential of LANDSAT data for use in coral reef surveillance, mapping and inventories.

38049 (CONF-7510172—P1, pp 595-609) **Techniques for studying sea ice drift and deformation at sites far from land using LANDSAT imagery.** Hibler, W.D. III; Tucker, W.B.; Weeks, W.F. (Army Cold Regions Research and Engineering Lab., Hanover, NH). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

A semi-automatic procedure for rapidly and accurately transferring ice coordinates from one LANDSAT image to another and for simultaneously estimating all linear measures of the ice deformation is described. The procedure takes into account the non-parallel

nature of the longitude lines and the finite curvature of the latitude lines, factors which are particularly critical in the polar regions. Necessary inputs are the location coordinates (latitude and longitude) of the center of each image and the location of two arbitrary points on a line of longitude on the image. This input information is then utilized in a set of equations which give the effective rotation and translation needed to transfer the north-south, east-west axes centered on one image onto similar axes on another image. These equations, which are valid over distances of several hundred kilometers, bypass the complex and time-consuming procedure of projecting points on the spheroid. After the transfer of common ice feature locations (on successive days) is completed, a least-squares program yields the average strain rate and vorticity with the strain rate being independent of errors in the transfer of the coordinate system.

38050 (CONF-7510172—P1, pp 611-619) **Spatial variability of ice thickness distribution as determined from LANDSAT-A.** Hall, R.T. (AIDJEX, Seattle). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

LandSat images of the Arctic pack ice have been used to measure a point on the ice thickness distribution, $G(h_1)$, and examine its variability on scales considered by the AIDJEX model. The variation of $G(h_1)$ as a function of sample size and distance is shown for three LandSat strips located in the Beaufort Sea for March and April 1973. In all cases there were spatial variation of $G(h_1)$ on a scale of 800 km, with shorter scale variations superimposed. Although the amplitude of the shorter scale variations sometimes equals the amplitude of the larger trends the preliminary conclusion is that the measurements support using a 100 km continuum element to characterize the ice thickness distribution.

38051 (CONF-7510172—P1, pp 621-631) **Evaluation of NOAA-2 VHRR imagery for Arctic Sea ice studies.** Ostheider, M. (Univ., Munich). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

Imagery taken in 1973 from NOAA-2 VHR-radiometers has been evaluated for monitoring Arctic sea ice. Considerations were devoted to analyzing the VHRR images according to three aspects: geometry, grey tone, and time.

38052 (CONF-7510172—P1, pp 633-636) **Passive radiowave sensing of the thickness and other characteristics of sea ice.** Tiuri, M.; Laaperi, A.; Jokela, K. (Helsinki Univ. of Tech., Otaniemi, Finland). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

During the spring of 1975 an extensive experiment to determine the characteristics of sea ice in the Baltic Sea by passive and active remote sensing methods was performed in cooperation with Finnish, Swedish and Dutch research groups. In this report the preliminary results of UHF and microwave radiometer measurements are described. The results indicate that 600 MHz and 5 GHz radiometers can be used to determine the ice thickness in the case of relative low salinity ice. Some information is also obtained about ice ridges.

38053 (CONF-7510172—P1, pp 637-646) **Remote sensor for measurement of a tidal current velocity.** Tsutsumi, S. (Kyoto Inst. of Tech., Sakyo, Japan); Itakura, Y.; Takagi, T. 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

An amplitude-modulated reticle finds some applications to remote sensing of image-velocity. This type of sensor with a PbS detector was built to test the feasibility of measuring the temporal variation of a rapid tidal current velocity in the Inland Sea. Feasibility has been demonstrated and it should be possible to develop a system that could measure the instantaneous tidal current velocity. A modified system, which can make a simultaneous measurement of the magnitude and direction of the tidal current velocity, is proposed by the authors.

38054 (CONF-7510172—P1, pp 647-651) **Remote sensing of the sea surface wave height spectrum using over-the-horizon radar.** Trizna, D.B.; Bogle, R.W.; Moore, J.C.; Moskowitz, L.I. (Naval Research Lab., Washington, DC). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

This paper briefly describes the joint NRL/NOAA/ITS over-the-horizon HF radar remote sensing program being conducted in the North Pacific from a site located on San Clemente Island off the coast of southern California. A description of the radar is given with regard to general system design, including a novel technique for switching between transmit and receive modes without the usual requirements of a high-power duplexer. The radar has been designed specifically for collection of sky-wave sea backscatter, with regard to elimination of ambiguous superimposed spectra due to sky-wave multipath, minimization of cell size, radar frequency agility for coverage of all desirable ranges for all times of day, etc. The experiments planned for the two-year program are also outlined, including both ground wave tests and sky-wave over-the-horizon tests.

38055 (CONF-7510172—P1, pp 653-659) **Detection and measurement of the oceanic thermal front east of Korea with the Defense Meteorological Satellite System.** Huh, O.K. (Naval Oceanographic Office, Washington, DC). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

The scanning sensors of the Defense Meteorological Satellite System (DMSS) have provided excellent thermal infrared (8 to 13 μm) and visual range (0.4 to 1.1 μm) imagery of the oceanic regions near the Korean Peninsula. These data were acquired by direct readout from the two polar orbiting satellites which passed over the region four times daily, near dawn, noon, early evening and midnight, local sun time. This high repetition rate increased the opportunities of obtaining clear sky conditions and allowed observations of the displacement of thermal water mass boundaries. Sea surface temperature gradient features including oceanic fronts, eddies, frontal waves, convergences and divergences are clearly depicted on the electro-optically contoured film display at 1.6°K contour intervals. This near real-time thermal infrared data (at 3.7 km spatial resolution) provided relative temperatures, some 2 to 10°K colder than the actual surface measurements. Thermal gradients were faithfully reproduced however, and could be estimated from the imagery to less than 1°K. The technical effectiveness of combining real-time high quality, high repetition rate satellite data with ship or aircraft operations has again been demonstrated as measurement traverses were deployed based on satellite data. A critique of the oceanographic capabilities of the system is provided as a guide to potential users.

38056 (CONF-7510172—P1, pp 661-670) **Biological and physical oceanographic remote sensing study aboard the CALYPSO.** Harlan, J.C. (Texas A and M Univ., College Station); Hill, J.M.; El-Reheim, H.A.; Bohn, C. 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

A multi-agency oceanographic remote sensing program was conducted in the Gulf of Mexico and the Caribbean Sea between November 1974 and February 1975 aboard the R/V CALYPSO. Remote sensors on satellites and on aircraft were used as operations and experiment planning tools as well as for scientific data acquisition. The experiments were designed to provide basic information for correlating ocean measurements with remotely sensed observations. The cruise was conducted in three legs. Three stations of Leg I (from Key West, Florida to Pensacola, Florida) were overflown by NASA's U-2 aircraft which carried the 10 channel prototype model (OCS). Preliminary analysis of digital data from one U-2 overflight has been completed. Reasonable correlation was found between in situ chlorophyll measurements over the sampling grid and the ratio of the red and green OCS band data even though low gradients of chlorophyll were measured. Leg II consisted of an investigation of the effect of the Mississippi River on the hydrology, chemistry, and biology of the Gulf of Mexico. ERTS data, processed and interpreted by GSFC was sent to the CALYPSO via ATS link within a 24 to 72 hour period after acquisition and used in planning the Leg II measurements. The program was extremely useful in the location of different water masses for the testing of various onboard and satellite-borne sensors. The weather images were also studied to help in the prediction of an annual lobster migration that Captain Cousteau hoped to film. Scientific data and proposed cruise tracks as well as coordinating information were transmitted between NASA and the CALYPSO through the ATS satellite system. The multi-agency research program onboard the R/V CALYPSO effectively demonstrated how satellite and aircraft imagery as well as satellite communications can support and enhance the study of the oceans.

38057 (CONF-7510172—P1, pp 139-148) **Automated measurement of sea surface temperature from a geostationary environmental**

satellite. Tarpley, J.D.; Raymond, B.A. (National Oceanic and Atmospheric Administration, Suitland, MD). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

An automatic technique has been developed to measure sea surface temperature using 10 μm infrared data from a geostationary operational environmental satellite. Temperature derivatives are used to discriminate between cloudy and cloud free areas. Sea surface temperatures are retrieved at a resolution of 25 km and checked against a first guess field that is maintained and updated daily.

38058 Mixing and transport. Ditmars, J.D. (Argonne National Lab., IL). *J. Water Pollut. Control Fed.;* **49**: No. 6, 1506-1523(Jun 1977).

A review is presented of various experiments and models developed for predicting mixing and transport in aqueous environments. Some dye studies are reported, for example in the determination of values for longitudinal dispersion, vertical diffusion and lateral diffusion coefficients in the Mississippi River. The thermal response of rivers to variable meteorological conditions and transient thermal discharges and flows was also modeled. For lakes and reservoirs, several numerical modeels for circulation and mixing are described. A discussion of the stratification of deep lakes is given, and one model predicts vertical variations in temperature, phosphorus, nitrogen, oxygen and algae in Lake Washington. Some models are described which predict estuarine flow, while for coastal waters and oceans, a model for mixing because of wave current interactions was developed, and showed that the angle between the surface waves and the coastal currents had an important effect on mixing. In relation to jets and plumes, models for buoyant surface jets and nonbuoyant submerged jets are presented. Acoustic techniques are mentioned for use in tracking the transport and mixing of drifting and settling sewage sludge in coastal waters. The interaction of surface waves and spilled oil was investigated, and a model described for the real-time prediction of oil slick transport and mixing in Delaware Bay.

38059 Grazing in juvenile stages of some estuarine calanoid copepods. Allan, J.D. (Univ. of Maryland, College Park); Richman, S.; Heinle, D.R.; Huff, R. *Mar. Biol.;* **43**: No. 4, 317-331(1977).

The grazing of juvenile Eurytemora affinis, Acartia tonsa and A. clausi from the Chesapeak Bay (USA) was investigated using natural particle distributions and freshly caught copepods, live-sorted into stages. Data were analyzed in greater than or equal to 110 size channels using an electronic particle counter, and filtering rates (FR) were estimated based on total particle removal (mean FR), and that for each size channel (giving maximum FR). Mean and maximum filtering rates increased from NVI (Nauplius Stage VI) through CVI (Copepodid Stage VI). Both rates plotted against weight satisfied a log fit best for A. tonsa, and a linear fit best for E. affinis. Results for A. tonsa were quite variable, apparently due to differences in temperature between experiments. Particle selection was investigated from the shape of the filtering rate curve over particle size. We define selective feeding by a FR curve which is higher in some size categories, and non-selective feeding by a flat FR curve. The general pattern was one of selective feeding in all copepodid stages of the three calanoid copepods investigated. E. affinis tended to "track" biomass peaks while Acartia spp.'s feeding was more variable, including feeding in size ranges of greater particle concentration, on larger particles, and in other size categories as well. Experiments with nauplii tended to yield flat FR curves, and it may be that selective grazing appears with, or is greatly accentuated by, metamorphosis from NVI to CI (Copepodid Stage I).

38060 Nitrogen, phosphorus, particulate and colloidal carbon content of sedimenting seston of a hard-water lake. White, W.S.; Wetzel, R.G. *Verh. Internat. Verein. Limnol.;* **19**: 330-339(Oct 1975).

Sedimenting seston was collected by means of an improved sedimentation trap biweekly at 4-meter intervals for over two years in a hard-water lake of southern Michigan. Chemical analyses of the sedimenting seston indicated significant spatial and temporal changes. A marked displacement of phosphorus from the epilimnion into the metalimnion was found in mid-summer. High rates of $CaCO_3$ precipitation, induced by photosynthesis, from the epilimnion facilitated nutrient removal to the hypolimnion. During fall overturn an average of 0.17 $\mu g\ m^{-2}\ day^{-1}$ of total phosphorus was resuspended. Total nitrogen content of the sedimenting seston changed throughout the year; a marked displacement to the hypolimnion occurred in late summer. Pronounced changes in the particulate organic carbon fraction, strongly related to primary productivity, were not as apparent as other parameters of the seston. Over one-third of the total calcium content is in the form of colloidal $CaCO_3$ that forms a major sink for inorganic and organic nutrients.

38061 (ORNL-tr—4631) **Introduced species in the overgrowth in the sea of Japan.** Zevina, G.B.; Kanenskaya, O.E.; Kubanin, A.A. [nd]. Translation by L. Kobylenski from pp 240-249 of Comprehensive data on nature in the sea, 5th issue, Moscow University Press, 1975. 10p. Dep. NTIS, PC A02/MF A01.

Many foreign vessels enter the Sea of Japan but only a few are protected from overgrowths sufficiently well so that they do not carry either animals or plants on their hulls. Most of them are covered by large or small amounts of overgrowths. Others carry a whole complex of Cirripeda crabs, molluscs, hydroids, pearlworts, Polychaeta, amphipods and other organisms. The introduction of new types of animals carried on sea vessels in the Sea of Japan was previously unnoticed but since 1963 introduction of the Cirripeda crabs, Balanus improvisus, and B. eburneus into this sea have been pointed out.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 36665, 36666, 36667, 36668, 36681, 36683, 36696, 36787, 36788, 36789, 36790, 36791, 36792, 36793, 36794, 36795, 36796, 36797, 36798, 36799, 36800, 36801, 36802, 36803, 36804, 36805, 36806, 36809, 36810, 36812, 36814, 36815, 36816, 36817, 36818, 36819, 36820, 36821, 36822, 36823, 36824, 36827, 36828, 36829, 36830, 36831, 36832, 36833, 36834, 36835, 36837, 36848, 37996, 37998, 37999, 38001, 38026, 38058, 38127, 38128, 38129, 38130, 38131, 38254, 38255, 38256, 38274, 38275, 38276, 38277, 38278, 38279, 38280, 38296

38062 (ARH-ST—149) **Hanford Pathline Calculational Program: theory, error analysis, and applications.** Friedrichs, D.R.; Cole, C.R.; Arnett, R.C. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). Jun 1977. Contract EY-76-C-06-2130. 116p. Dep. NTIS, PC A06/MF A01.

The Hanford Pathline Calculational Program (HPCP) is a numerical model developed to predict the movement of fluid particles from one location to another within the Hanford or similar groundwater systems. As such it can be considered a simple transport model wherein only advective changes are considered. Application of the numerical HPCP to test cases for which semianalytical results are obtainable showed that with reasonable time steps and the grid spacing requirements HPCP give good agreement with the semianalytical solution. The accuracy of the HPCP results is most sensitive in areas near steep or rapidly changing potential gradients and may require finer grid spacing in those areas than for the groundwater system as a whole. Initial applications of HPCP to the Hanford groundwater flow regime show that significant differences (improvements) in the predictions of fluid particle movement are obtainable with the pathline approach (changing groundwater potential or water table surface) as opposed to the streamline approach (unchanging potential or water table surface) used in past Hanford groundwater analyses. This report documents capability developed for estimating groundwater travel times from the Hanford high-level waste areas to the Columbia River at different water table levels.

38063 (CONF-7510172—P1, pp 275-282) **Degradation of the vegetation cover with urbanization and its influence on the flow of polluted air.** Nakajima, I. (Ministry of Agriculture and Forestry, Tokyo). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

Along with the degradation of vegetation cover and the constant spread of artificial surface structures such as concrete buildings and asphalt pavements, urbanization is seen to cause a rapid increase in surface radiation heat. The hot air-mass rising above such surfaces bring, in turn, the inflow of polluted air to densely populated urban areas. Urban planning, therefore, must include measures to conserve adequate vegetation cover. It was explained how polluted air comes to be concentrated as a result of hot air masses rising over densely populated areas with little vegetation cover—a phenomenon caused by radiation heat waves. It was also seen that the ratio of radiation heat waves is closely related with the type of land surface. This ratio increases rapidly when surface vegetation dips below 30-25 percent of the total surface area. A study was made by LANDSAT and through aerial photography of metropolitan Tokyo's surface temperature pattern taken during the morning hours and again at noon. Tokyo's bio-environmental quality pattern was likewise mapped, using the numerical score chart which deduced the relationship between pollution-caused vegetation damage and land surface conditions. These results have served to show us what minimum percentage of surface vegetation is needed in urban areas. It is also an effective method of conducting environmental quality surveys over wide regions.

38064 (CONF-7510172—P1, pp 283-291) **Measurements of vegetation stress by a multispectral scanner as a basis for air quality maps.** Marschalek, H. (SPACETEC GesmbH, Vienna). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

For the elaboration of air quality maps, methods which give an extensive overview were looked for. As the first tests demonstrated, multispectral scanner images are especially appropriate for this purpose. In this method the tree is used as an indicator. The measured degree of the damage (due to air pollution) for different tree sorts (in different plant conditions) was standardized in such a way that it was possible to make conclusions about the air quality. A practical example as well as a general concept are described here.

38065 (CONF-7510172—P1, pp 337-343) **Great Lakes environmental land use mapping.** Risley, C. Jr. (Environmental Protection Agency, Chicago). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

The Government of Canada and the United States requested the International Joint Commission to conduct a study of pollution of the boundary waters of the Great Lakes System from agriculture, forestry, and other land use activities. A program was proposed by the U.S. EPA in support of the Great Lakes Water Quality Agreement of 1972 to furnish a land use inventory of the U.S. portion of the Great Lakes Drainage Basin. This land use inventory will be used to quantify pollution from land use activities in the U.S. portion, while Canada is charged with the responsibility of obtaining a similar inventory for the Canadian portion of the Great Lakes Drainage Basin. The project uses earth research technology satellite (ERTS) imagery and advanced sophisticated computer technology to meet this need. The Laboratory for Applications of Remote Sensing (LARS), Purdue University, has produced the desired inventory under contract from EPA using computer analysis of multispectral scanner data obtained by ERTS. Land use classes were spectrally separated by the analysis into 17 classes including four primary classifications; Urban-Commercial-Industrial, Agricultural, Forest, and Water (wet-lands, etc.) and secondary level classifications in further detail such as density of urban use and types of agricultural use such as row crops, pasture and meadows.

38066 (CONF-7510172—P1, pp 401-410) **Remote sensing investigation on Lake Biwa.** Sakata, T. (Tokai Univ., Hiratsuka City, Japan); Shimoda, H.; Tanaka, K.; Suzuki, T. 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

Remote sensing technique was applied to a limnological survey. Multi-band photographs of Lake Biwa in Japan were taken from a helicopter with 4 Hasselblad cameras while field observation and sampling of lake water were made from a boat. The multi-band images were analyzed with an analog processer TIAS-I. Plumes of river discharges and several kinds of coastal plants were enhanced with this analysis.

38067 (CONF-7510172—P1, pp 555-562) **Swedish remote sensing program.** Zenker, S. (Swedish Space Corp., Stockholm). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

A brief description is given of Sweden's overall strategy in developing operational remote sensing systems to help solve pressing national problems. Oil spill surveillance and sea-ice mapping are given as two applications where an operational capability is expected within the short-term future.

38068 (UCRL—52416) **Feasibility study for the computerized automation of the Laboratory Services Branch of EPA Region IV.** Boyle, W.G. Jr.; Barton, G.W. Jr.; Taber, L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 10 Mar 1978. Contract W-7405-ENG-48. 35p. Dep. NTIS, PC A03/MF A01.

This report is a study of the feasibility of computerized automation of the Laboratory Services Branch of the Environmental Protection Agency's Region IV. The LSB provides chemical analytical support for a number of EPA divisions; its primary function at present is compliance monitoring, field surveys, and oil identification. Automation of the LSB is not only feasible but also highly desirable. Automation systems are proposed that will make major improvements in analytical capacity, quality control, sample management, and reporting capabilities. Most of these automation systems are similar to those already developed and installed at other EPA laboratories. These systems have options that include limited modifications suggested as a result of the study of the LSB Laboratory, and also include communications hardware and software for a Sample File Control host computer. It is estimated that the initial cost of three of the four options considered would be recouped in approximately three years through increased capacity and efficiency of operation.

38069 (UCRL—80739) **Asymptotic estimation error growth applied to monitoring.** Pimentel, K.D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 9 Feb 1978. Contract W-7405-ENG-48. 12p. (CONF-780519—1). Dep. NTIS, PC A02/MF A01.

From Conference on applications of kalman filtering theory and technique to hydrology, hydraulics and water resources; Pittsburgh, PA, USSR (22 May 1978).

Problems in the design of optimal measurement systems for monitoring pollutant levels in a confined aquifer are discussed. It is assumed that a two-dimensional region Z exists within an aquifer into which a collection of stochastic and deterministic point sources are injecting a pollutant species. It is required to design a monitoring system whereby best estimates of the pollutant concentration p throughout the region Z may be made from a limited number of point measurements made at discrete times. The constraint on the design of the monitoring program is that it be the minimum-cost program of measurements that maintains the error in the pollutant estimate below a known bound at all times. The growth of estimation error in the Kalman Filter was studied in relation to problems of monitoring pollutant dispersal in a confined aquifer. Asymptotic properties in the error growth result for systems with diffusive transport and homogeneous boundary conditions. These properties lead to simple solutions to the optimal design of pollutant monitoring systems, the minimum-cost measurement program which maintains the error in the pollutant estimate below a given bound.

38070 Determination of trace element contamination of sediments by multielement analysis of clay-size fraction. Helmke, P.A.; Koons, R.D.; Schomberg, P.J.; Iskandar, I.K. (Univ. of Wisconsin, Madison). *Environ. Sci. Technol.;* **11**: No. 10, 984-989(Oct 1977).

Samples of total sediments and the clay-size fraction are analyzed for more than 20 elements to evaluate the use of trace element concentrations in the fine fraction to determine if the sediments have received anthropogenic inputs of elements. The samples are from Lake Superior and the harbor of Duluth, Minn., and Superior, Wis. The concentrations of trace elements in the samples of total sediments vary by more than a factor of two over the study area, and they are not related in a simple fashion to sample location. The ability to detect contaminated sediments is not improved when the values of concentrations are corrected for the effects of dilution by quartz. In contrast, the concentrations of trace elements in the clay-size fraction vary less than 15% from their mean values from site to site except for some areas that have high concentrations of Cr, Cu, Zn, Hg, and As. The high concentrations of these elements result from anthropogenic inputs.

38071 Heavy metals and related trace elements. Leland, H.V. (Geological Survey, Menlo Park, CA); Luoma, S.N.; Wilkes, D.J. *J. Water Pollut. Control Fed.;* **49**: No. 6, 1340-1369(Jun 1977).

A review is given of heavy metals and related trace elements in the aquatic environment. Other reviews and bibliographies are cited, dealing with the metabolism and transport of metal ions and with the toxic effects of stable and radioactive trace metals on aquatic organisms. The sources of trace elements in natural waters are discussed. It is suggested that atmospheric inputs of several trace metals comprise sizable fractions of total inputs to the Great Lakes and continental shelf waters. Information on stack emissions of trace elements from a coal-fired steam plant was used to estimate the likely range of air concentrations and inputs to a forested watershed in Tennessee. Some basic concepts of cycling of elements through aquatic communities were examined, such as the Pb, Mn and Zn concentrations in sediment and estuarine plants and animals colonizing dredge-spoil disposal areas. The use of plants as biological indicators of trace element contamination was outlined, as well as bioaccumulation in aquatic fauna. The effects of environmental factors on the kinetics of element exchange were noted, for example the influx rates of Cs 137 in tubificid worms, and Co 60 and Zn 65 in shrimp were shown to be temperature dependent. The toxicity of heavy metals on aquatic fauna was discussed, such as the histopathological lesions in the kidney and liver of fishes caused by heavy metals, and the effects of Hg and Cu on the olfactory response of rainbow trout.

38072 Continuous-flow apparatus for use in petroleum bioassay. Vanderhorst, J.R.; Gibson, C.I.; Moore, L.J.; Wilkinson, P. (Battelle Pacific Northwest Labs., Sequim, WA). *Bull. Environ. Contam. Toxicol.;* **17**: No. 5, 577-584(May 1977).

A system was designed for long-term bioassay of dispersed petroleum derivative, with samll amounts of insoluble material, in stable seawater concentration. The system permits simultaneous development of long-term biological indicators of oil contamination

and a standardized, sensitive set of analytical methods. A description is given of the device which continuously extracts dispersed No. 2 fuel oil derivative in seawater. Illustrations are shown of the fuel oil dispersion and bioassay apparatus, the mariotte bottle used for metering fuel oil, the separation devices, and the dispersion metering tank. Distinguishable concentrations were obtained and maintained over the 96-h test periods for the various dispersed oil dilutions, thus demonstrating the feasibility of the system.

38073 Concentrations of oil in sea water resulting from natural and chemically induced dispersion of oil slicks. Cormack, D.; Nichols, J.A. (Warren Spring Lab., Stevenage, Eng.). pp 381-385 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

Results are presented on the factors relating to the dissipation of oil spills at sea, including evaporation, emulsion formation, spreading, and natural dispersion into the water column. For Ekofisk oil, 20 percent evaporates in about 7.5 hours and, while emulsion formation is as rapid as for Kuwait crude, the resulting viscosity is low and insufficient to allow interference with the natural spreading and dispersion rates. Spreading has two components. One is controlled by surface tension-viscous drag forces and the other is wind-induced. Together they contribute to the two dimensional dissipation of the oil so that subsequent oil concentrations in the sea are, of necessity, low. These concentrations were measured for naturally dispersing and chemically dispersed slicks. The chemically-dispersed slicks were of two kinds. One was previously weathered for three hours, the other was of controlled thickness and was dispersed immediately upon being laid. Resulting concentrations of oil in the sea are low and of short duration compared with those required to give observable effects in laboratory toxicity studies. No significant deleterious effects were found to result from the dispersion of oil slicks at sea using low toxicity dispersant chemicals; also it was noted that, in any case, substantial quantities of oil can be expected to enter the sea before oil recovery operations can be mounted.

38074 Dispersant field trials in Canadian waters. Gill, S.D. (Canadian Coast Guard Emergencies, Ottawa). pp 391-394 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

During the summer of 1975 and the winter of 1976, the Canadian Coast Guard Marine Emergency Organization conducted field trials on a number of commercial oil dispersants using the Warren Springs type of testing apparatus. These field trials, part of an ongoing program, were undertaken to gain a better appreciation of the effectiveness of dispersants in both warm and cold water. The results of tests conducted on the five products reported hereunder indicate that the new concentrates represent a considerable improvement over the more conventional oil dispersants with the implication of improved application logistics. Data obtained from the work done in colder weather suggests that oil dispersant performance deteriorates somewhat under colder conditions.

38075 Utilization of dispersants in offshore areas. Fitzgerald, D.E. (Atlantic Richfield Co., Dallas). pp 395-398 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

The use of dispersants to control marine oil spills is common practice in many areas throughout the world. In the United States, the use of dispersants has been discouraged up to this time by federal regulations. A Task Force was appointed by the American Petroleum Institute to make recommendations on the utilization of dispersants based on studies of current information on dispersants and mechanical recovery equipment. The use of dispersants should be encouraged where it is justified. The Task Force believes that the use of dispersants can at times be the most effective and biologically sound method of controlling offshore oil spills. For this reason, we would like to see the National Contingency Plan revised so that the responsible On-Scene Coordinator (OSC) has more authority over the use of dispersants. The OSC should be able to decide to use dispersants to control offshore oil spills that threaten to move into sensitive environmental or commercial areas. If the plan is revised, then oil spill cleanup organizations would be encouraged to have stocks of low toxicity dispersant, and suitable spraying systems.

38076 Computer simulation technique for oil spills off the New Jersey—Delaware coastline. Lissauer, I.M.; Bacon, J.C.; Miller, M.C. (Coast Guard Research and Development Center, Groton, CT). pp 437-440 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

Predictions of the trajectories of oil slicks and their impact locations along the shoreline of New Jersey and Delaware were determined for two potential deepwater ports and two potential drilling sites. A hydrodynamical-numerical model for the New York Bight area was coupled with a wind generating model to produce temporal patterns of concentration of oil. The wind model employs pressure distributions and storm movement to produce hourly patterns of the wind field produced by any storm for a predetermined grid area. Shoreline impact determinations were made for the four spill sites for the average winter storm conditions and average summer high pressure systems generated by the models. Winter storms moving through the study area do not pose a high risk to the shoreline should a spill occur. The maximum transport from the four sites toward the shore was 18 miles. This left the slick well offshore so that the ensuing wind shift from the frontal passage would rapidly transport the oil seaward. During a stagnant summer high pressure system, spills occurring within fifty miles of the shoreline have a high probability of impacting the shoreline if the spill should occur at the beginning of the period in which the system affects the area.

38077 New York Harbor oil drift prediction model. Kollmeyer, R.C.; Thompson, M.E. (Coast Guard Academy, New London, CT). pp 441-445 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

An operational predictive oil slick movement model is developed and applied to New York Harbor. This computer simulation employs hourly tidal currents for all stages of the tide as input data, combined with river flow and continuous wind data to predict oil slick movement. Slick spreading and transport is accomplished using a conservative form of the diffusion/advection equation. The shape of the slick as well as its possible separation into multiple slicks due to current divergence is predicted. Time steps on the order of three minutes and grid spacing of 200 meters allow short term, small scale slick position and shape predictions to facilitate quick response for location of sites for containment or cleanup activities. Hindcasting features allow for possible source location of the initial spill.

38078 Use of a diagnostic circulation model for oil trajectory analysis. Galt, J.A.; Pease, C.H. (National Oceanic and Atmospheric Administration, Seattle). pp 447-454 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

A diagnostic circulation model designed for the continental shelf region was used to study water parcel trajectories. The model assumes a combination of geostrophic plus Ekman dynamics and is diagnostic in that it uses fluid density data (obtained from a typical oceanographic cruise; i.e., STD stations) and wind stress data to specify the baroclinic and surface Ekman modes of the flow. The model then solves for the remaining barotropic and bottom Ekman modes subject to the constraints imposed by continuity and bathymetry. Variations in the boundary conditions correspond to variations in the mean inflow/outflow surface currents, or barotropic mode. Using this correspondence, the model was keyed to the measurements obtained from a moored current meter array and a time stepping procedure was developed. This allows the model to generate a continuous time- and space-varying representation of the regional flow field. Field data for the Northeast Gulf of Alaska were used in the model equations which were solved using finite element techniques. The predicted currents and trajectories for a variety of runs were compared against observational data.

38079 Storm related oil spill movement on the Beaufort Sea shelf. Hufford, G.L.; Lissauer, I.M.; Thompson, B.D. (Coast Guard Research and Development Center, Groton, CT). pp 455-460 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

A storm model is developed and applied to the north Alaskan coast. The model is used to generate wind fields from various storms which have occurred during the past 20 years. The wind fields generated are used to study the wind drift trajectories of oil spills from five different sites along the north Alaskan coast. The probability of an oil slick impacting the shoreline from the five different sites is discussed for different storms. Environmental risk analysis is discussed for drilling sites at different distances from the shoreline.

38080 Fate of crude oil spilled in a simulated Arctic environment. MacGregor, C.; McLean, A.Y. (Canplan Oceanology Ltd., Halifax, Nova Scotia). pp 461-463 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

A simulated Arctic crude oil spill was investigated by monitoring physical and chemical changes in a laboratory spill of Guanipa (Venezuelan) crude. The spill consisted of one gallon of crude on 100 gallons of synthetic seawater contained in a fiberglass tank fitted with a wave generator and a controlled radiation system, all located in an environmental chamber held at 2°C. Changes in oil composition were monitored using a gas liquid chromatograph. Evaporation removed the largest quantity of material from the spill, the rate varying directly with the exposure time to solar radiation. Solution or sinking removed only minimal quantities of oil although the influence of these factors increased with time. The most notable physical change was the rapid formation of stable emulsions. These emulsions formed discrete lumps commonly referred to as "tarballs." The formation of tarballs occurred within a few days after the spill and they remained stable over the four-month duration of the experiment. Their formation drastically reduced weathering effects by removing the bulk of the oil from contact with the air/seawater interface. It was concluded that a crude oil spill in the Arctic could contribute significantly to tarball pollution of northern oceans. Tarball formation is not limited, therefore, to warm waters and occurs independently of weathering processes. It would appear that tarball formation depends more on the chemical composition of the oil and the rate of formation depends upon the available wave mixing energy. The ultimate fate of oil spilled in Arctic regions could be in the form of persistent tarballs.

38081 Fate of oil from the supertanker Metula. Hann, R.W. Jr. (Texas A and M Univ., College Station). pp 465-468 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

The oil from the Metula spill is disappearing at varying rates at different locations on Tierra del Fuego. The exposed coastline is hiding or dissipating the oil into the sea by wave turbulence, blowing sand, and deeper penetration into the beach. Beach detritus such as oiled kelp and kelp holdfasts, lumber and trash will probably be the longest-lived evidence of the spill. In the estuaries and protected areas, the rate of change is much slower and confined to the aging and hardening of the oil by air exposure and deeper penetration into the sediments. Removal is evident only where greatest energy is exerted, in high velocity flowing channels and exposed beach top areas. Some fossilized birds still are in evidence. Salicornia is beginning to recover and grow through some oil deposits where previous stalks were present. The magnitude of the Metula spill coupled with the absence of any cleanup activity has made the spill serve a valuable role as a test system for observing recovery from a major oil spill in a cool climate.

38082 Effects of pelagic hydrocarbons on the rocky intertidal flora and fauna of Bermuda. Maynard, N.G. (Bureau of Land Management, Anchorage, AK); Gebelein, C.D.; Zsolnay, A. pp 499-503 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

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Over the past decade, the islands of Bermuda have been exposed to an increasing influx of floating pelagic hydrocarbons ("tar balls"). Large quantities of the pelagic tar become stranded on the rocks in the intertidal zone. Tar coverage on the rocks is controlled by the slope of the shore, with the maximum amount accumulating on gently sloping or flat shores. The tar is deposited almost exclusively in the splash zone, and, therefore, the only animals directly affected by the attached tar are those who inhabit and/or feed in this zone. Chemical analyses show that the snails, Nodilittorina tuberculatus and Tectarius muricatus, which live in the splash zone, have the highest hydrocarbon content in body tissue of all animals analyzed. In contrast, all animals sampled from immediately adjacent tide pools contained no petrogenic hydrocarbons. The most abundant life in the intertidal zone is concentrated below this splash zone area of tar accumulation. With few exceptions, the animals from this zone have demonstrated low or zero levels of petrogenic hydrocarbons in the body tissue. The presence of tar on the rocks does not appear to adversely affect reproductive potential, size frequency or abundance of the animals in this intertidal region below the splash zone. The microscopic and macroscopic algae produce very large amounts of biogenic hydrocarbon material. In addition, however, some algal samples from sites of heavy tar accumulation contained high levels of petrogenic hydrocarbons.

38083 Ecological effects of experimental oil spills on eastern coastal plain estuarine ecosystems. Bender, M.E.; Shearls, E.A.; Ayres, R.P.; Hershner, C.H.; Huggett, R.J. (Virginia Inst. of Marine Science, Gloucester Point). pp 505-509 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

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Five segments of a mesohaline marsh located off the York River in Virginia were physically isolated from the surrounding area, except for allowing subtidal flow, and dosed with fresh and artificially weathered South Louisiana crude oil. The experimental design and field site utilized in this study are described. The mini-ecosystems each contained about 695 m^2 of marsh, 100 m^2 of open water and 15 m^2 of intertidal mud flat. In September 1975, three barrels (570l) of each of the experimental oils were spilled into replicate systems. Overall, the artificially weathered oil was shown to have as great an ecological impact on the communities as the fresh crude. Phytoplankton and fish populations all showed greater declines following the spills in the weathered oil systems. Phytoplankton production declined immediately after both oil spills but had recovered to control values within seven days. Species composition was not affected by the oils, while periphyton biomass, as measured by adenosine triphosphate (ATP), increased after both treatments. Marsh grass production was reduced in both spill units. Benthic animals, showing population declines after both oil spills, included nereid polychaetes, insect larvae and amphipods. Oligochaete populations decreased shortly after the fresh crude spill, returned to normal within 30 days, and then declined again relative to the control in both treatments 11 weeks after the spill. Mortalities of fish, Fundulus heteroclitus, held in live boxes were noted only in the weathered treatment systems.

38084 Chemical investigations of two experimental oil spills in an estuarine ecosystem. Bieri, R.H.; Stamoudis, V.C.; Cueman, M.K. (Virginia Inst. of Marine Science, Gloucester Point). pp 511-515 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

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The fate of fresh and artificially weathered South Louisiana crude oil was investigated in large-scale experimental oil spills. The oil, originally introduced to the surface of a creek bounded by walls of transite (but open at subtidal level to allow communication with surrounding waters), was distributed by tidal action over a marsh of Spartina alterniflora. Samples of surface film, water, organic detritus, sediment, fish (Fundulus heteroclitus), oyster (Crassostrea Virginica), and clam (Mercenaria mercenaria) were collected over long periods and subjected to detailed chemical analysis by gas chromatography and computerized low resolution GC-MS techniques. Results are presented for water and Fundulus. Maximum concentrations of individual aromatic compounds found in fish were similar for both oils. This maximum occurred six hours after the spill for weathered crude, and 76 hours after the spill for fresh crude for all aromatic compounds except naphthalene and the methylnaphthalenes. Uptake appeared to be non-specific. In all cases investigated, hydrocarbon concentrations in animal tissue reached a maximum and then decreased to levels below measurability (less than 10 ppb). In the interpretation of the data, a distinction is made between environmental residence times observed in natural systems and the biological residence times measured in laboratory experiments.

38085 Microbial responses after two experimental oil spills in an eastern coastal plain estuarine ecosystem. Kator, H.; Herwig, R. (Virginia Inst. of Marine Science, Gloucester Point). pp 517-522 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

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Three large transite-sided enclosures, constructed in a tidal salt marsh in southeastern Virginia, were utilized to evaluate the effects of crude oil spillage on selected microbial population. Unweathered Louisiana crude oil was spilled in one enclosure, artificially weathered South Louisiana crude in another, and the third served as a control. Each enclosure was constructed so as to allow unhampered exchange with tidal flow on the tidal creek side. Heterotrophic bacteria and fungi, chitinolytic, cellulytic and petroleum-degrading bacterial populations from the tidal creek, and sediments in intertidal, mid- and back-marsh zones were enumerated at selected intervals following the oil spills. Dominant petroleum-degrading and heterotrophic bacterial isolates were selected for taxonomic grouping. Within several days following the spills, the levels of petroleum-degrading bacteria rose by several orders of magnitude relative to the control enclosure. This differential has been maintained for approximately one year. Plots of the ratio of oil-degrading to heterotrophic bacteria reveal enhancement of the petroleum degrading component of the heterotrophic populations. Mean levels of chitinolytic, cellulytic, heterotrophic bacteria and fungi were not statistically different in the oil and control enclosures. The potential significance of these observations is discussed.

38086 Chesapeake Bay oil spill, February 2, 1976: a case history. Roland, J.V.; Moore, G.E.; Bellanca, M.A. (Virginia State Water Control Board, Richmond). pp 523-527 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

On February 2, 1976, one of the worst oil spills in recent history occurred in the lower Chesapeake Bay. Approximately 250,000 gallons of No. 6 oil were discharged into the bay after a barge, the STC-101, sank in a storm near the mouth of the Potomac River. The oil contaminated extensive beach and marsh areas on both sides of the bay. Cleanup operations lasted almost a month and the cost approached $400,000. The U.S. Coast Guard estimated that 167,000 gallons of oil were recovered by cleanup crews. The remaining oil is believed to be widely dispersed over large areas of the bay—possibly tied up in fringe marsh grass, buried under sand on the beaches or carried out into the Atlantic Ocean. The heavily-contaminated fringe marsh grasses were cut, leaving the root systems intact, in order to protect the fragile marsh areas. An overall assessment of the environmental damages caused by the spill is almost complete. Estimates of the number of waterfowl killed range from 20,000 to 50,000 birds. Damage to shellfish and other aquatic resources is still under study. Preliminary reports indicate that damages to the environment may not be as severa as initially expected.

38087 Effects of the Chesapeake Bay oil spill on salt marshes of the lower Bay. Hershner, C.; Moore, K. (Virginia Inst. of Marine Science, Gloucester Point). pp 529-533 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

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A study to determine the effects of the Chesapeake Bay oil spill of February 1976, and of the subsequent cleanup operations was conducted on the eastern shore of the Bay. The primary objective was to assess the biological impact on the marshes at the population level. Populations of intertidal mussels, Modiolus demissus, and oysters, Crassostrea virginica, showed no significant short-term effects. The population of the snail, Littorina irrorata, was significantly reduced, but appears to be recovering well. The dominant marsh grass Spartina alterniflora showed increased net productivity as measured by standing crop, increased density, decreased mean height, and increased flowering success. Hypotheses to explain these observations are discussed. The impact of the spill on the marshes is thought to have been minimized by virtue of the relatively low toxicity of the oil, the time of year the spill occurred, and the comparatively high energy environment of the shoreline.

38088 Effects of the March 18, 1973 oil spill near Cabo Rojo, Puerto Rico on tropical marine communities. Nadeau, R.J. (Environmental Protection Agency, Edison, NJ); Bergquist, E.T. pp 535-538 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

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During the early morning hours of March 18, 1973 the Greek tanker, Zoe Colocotronis spilled 37,000 barrels of Venezuelan crude oil into the coastal waters of southern Puerto Rico. About 24,000 bbl of oil washed ashore at Cabo Rojo, contaminating sandy beaches, turtle grass, and rocky shore communities. Within 48 hours following the spill, dead and moribund invertebrates, representing several distinct phyla were being deposited along the beach and intertidal zone. Population analysis of the affected mangrove prop root and sublittoral turtle grass (Thalassia) communities revealed a sparse and impoverished fauna. Subsequent survey trips have revealed marked increases within certain affected populations. In one area (1.0 hectare) the red (Rhizophora mangle) and black (Avicinnia nitita) mangrove trees have defoliated and died during the three years following the spill. Analysis of the sediments in this area indicates significant levels of petroleum hydrocarbon residues were present as of January 1976.

38089 Five-year recruitment of marine life after the 1971 San Francisco oil spill. Chan, G.L. (Coll. of Marin, Kentfield, CA). pp 543-545 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

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On January 18, 1971, two Standard Oil tankers collided underneath the Golden Gate Bridge, releasing about 840,000 gallons of Bunker C fuel. An estimated 4.2 million to 7.5 million intertidal invertebrates, chiefly barnacles, were smothered by the oil. Five-year observations of marine life recruitment following the spill indicate that population densities of some marine species have significantly increased in the San Francisco Bay area intertidal zones at Sausalito and Duxbury Reef. With some fluctuations, the barnacles Balanus glandula and Chthamalus dalli have increased from July 1971 to May 1976—from 93 to 189 barnacles per dm^2 at Sausalito and from nine to 34 per dm^2 at Duxbury Reef. The large bed of mussels, Mytilus californianus, showed a steady rise from $5.9/m^2$ in April 1971 to $14.0/dm^2$ in July 1976. The density of mobile organisms, such as limpets, snails, crabs, and starfish, all show cyclical variations; some show an overall increase. The limpets, Collisella spp., which suffered high mortality during the spill have increased threefold over pre-oil counts. In 1975, some significantly low sample means were recorded for barnacles in Sausalito and for 18 composite species at Duxbury Reef, probably due to natural ecological forces. The five-year recruitment (1971-76), however, shows no evidence of lasting detrimental effects of Bunker C oil on the populations of marine life within the transect sites.

38090 Extractable organics and nonvolatile hydrocarbons in New York Harbor waters. Searl, T.D. (Exxon Research and Engineering Co., Linden, NJ); Huffman, H.L. Jr.; Thomas, J.P. pp 583-588 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

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In conjunction with the Marine Ecosystem Analysis program in the New York Bight, selected stations in New York Harbor were sampled during November 1974, and March and June 1975, for carbon tetrachloride-extractable organics and nonvolatile hydrocarbons. The extractable organics ranged from 64 to 840 μg/l with a mean value for the Harbor of 158 μg/l. The standard deviation, 2 sigma, of the test method, based on duplicate samples, was 26 μg/l. The nonvolatile hydrocarbons ranged from 14 to 270 μg/l with a mean of 39 μg/l. The standard deviation, 2 sigma, was 5 μg/l. The highest concentration of organics and hydrocarbons was found in Newtown Creek; the lowest at the entrance to Ambrose Channel. The average concentrations are about a factor of ten above those reported for the open ocean. The concentrations obtained on the three sampling dates did not differ widely. To help establish distribution patterns, ammonia, salinity, turbidity, and other measurements were made. In Arthur Kill, ammonia was constant at 50 μg-atoms N/l while the ratio of hydrocarbons to organics dropped from 0.29 at Newark Bay to 0.12 at Raritan Bay. This suggests that oxidation and/or adsorption of hydrocarbons onto particulates with subsequent settling took place.

38091 Distribution of volatile hydrocarbons in some Pacific Ocean waters. Koons, C.B. (Exxon Production Research Co., Houston, TX). pp 589-591 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

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Recent studies conducted by several investigators indicate that the volatile hydrocarbons in the C_4 to C_8 range, including benzene and toluene, are generally more toxic to marine life than the higher molecular weight hydrocarbons. However, very little data have been published on the distribution of these volatile hydrocar-

bons in the world's oceans. During 1974, ocean water samples were collected from tankers along three routes, including: U.S. west coast (San Francisco) to Cook Inlet, Alaska; U.S. west coast (San Francisco) to Panama; and U.S. west coast (San Francisco) to Singapore. One hundred thirty-eight samples were taken near the surface and at a depth of about 10 meters and were analyzed for total volatile (C_4—C_8) hydrocarbons. For the near-surface samples, a median concentration of 0.33 ppB (by weight) was found; for the -10 meter samples, a median of 0.10 ppB. Some variations in amounts were observed according to the geographic location of the samples. Sampling and analysis methods are briefly discussed.

38092 Microorganisms and hydrocarbons in the North Sea during July—August 1975. Oppenheimer, C.H. (Univ. of Texas Marine Science Inst., Port Aransas); Gunkel, W.; Gassmann, G. pp 593-609 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

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The 1975-1976 North Sea Oil Ecology Investigation is designed to determine the dynamics of oil pollution in the North Sea and to serve as a baseline study at the start of the rather extensive oil exploitation of the seabed of the North Sea. In designing the experiment, particular attention has been paid to the 1974-1975 research effort of the Gulf Universities Research Consortium directed towards determining the effect, if any, of offshore oil exploitation in Louisiana on the area's ecology. As a result, both projects address the distribution of hydrocarbons and their possible concentration in the water, sediment, and living organisms, and the determination of the rates of degradation and effect of hydrocarbons on the food web. Preliminary analyses and study of cruise data taken in the North Sea during July-August 1975 indicates that there appears to be a tendency for higher numbers of microorganisms to be associated with the most active oil field, "Ekofisk"; there is also some indication of microbial response to outflow from the Elbe River. The uniform low levels of hydrocarbons in the sediment suggest that microorganisms are active as shown by ratios of higher hydrocarbon bacteria to heterotrophs in the "Ekofisk" area.

38093 Fate of petroleum components in estuarine waters of the Southeastern United States. Lee, R.F. (Skidaway Inst. of Oceanography, Savannah). pp 611-616 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

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Radiolabeled hydrocarbons and phenols were added to water samples from the Skidaway and Cooper Rivers, two estuarine rivers on the U.S. south Atlantic coast. The adsorption of hydrocarbons to particles and microbial degradation of different petroleum components were the processes studied. Alkanes, low molecular weight aromatics (benzene, toluene, naphthalene and methylnaphthalene) and phenols were rapidly degraded to $^{14}CO_2$. Low degradation rates were observed for the higher weight polycyclic aromatic hydrocarbons, fluorene, anthracene, benz(a)anthracene, and benz(a)pyrene, and from 12 to 70 percent of these hydrocarbons were absorbed to suspended particles in the water. Radioautographs of particles after the addition of ^{3}H-benz(a)pyrene and ^{3}H-hexadecane to the water samples indicated the hydrocarbons associated with detrital particles. This detritus was composed of a mixture of clay, organic matter, plankton remains and living microbes. One area of the Cooper River had visible oil slicks and the degradation rates of added heptadecane (20 μg/l), naphthalene (30 μg/l) and methylnaphthalene (30 μg/l) were 0.4, 2.8 and 1.1 μg/l/day, respectively. In contrast, at a downstream site, where there were no visible slicks, the degradation rate of these same hydrocarbons were 0.1, 0.7 and 0.1 μg/l/day, respectively. Estuarine water had much higher hydrocarbon degradation rates than offshore and Gulf Stream waters.

38094 Lead distribution in the Cape Fear River estuary. Baier, R.W. (Duke Univ. Marine Lab., Beaufort, NC). *J. Environ. Qual.;* 6: No. 2, 205-210(1977).

Water and mud samples collected during 1973 and 1974 from the Cape Fear River, the region of its plume, and adjacent slope waters were analyzed for lead (Pb) by anodic stripping voltammetry and atomic absorption spectroscopy. Partitioning among adsorbed, strongly complexed, and electroactive states of Pb in seawater was estimated by filtration and voltammetric analyses at two pH levels. A significant fraction of the Pb present was found to be complexed in river water, but was dissociated upon mixing with shelf water. The concentration of Pb in offshore sediment decreased with increasing grain size. All concentrations of Pb found in the Cape Fear River estuary were well below recognized lethal values for aquatic life.

38095 Partitioning and transport of lead in Lake Washington. Baier, R.W.; Healy, M.L. (Duke Univ. Marine Lab., Beaufort, NC). *J. Environ. Qual.;* 6: No. 3, 291-296(1977).

Input of lead to Lake Washington appears to result from the settling of airborne Pb onto surface waters and the washing of terrestrial accumulations to the lake as runoff. Some of the Pb received by the lake is associated with particles that sink, while the remainder leaves the lake with the overflow. The range in Pb concentration during 2 years of sampling was 0.04 to 6.6 ppb. The path of Pb to the sediments is not direct but involves cycling through both liquid and solid phases. Over 70% of the total Pb entering the lake is retained by sediment. Lead in top layers of sediment ranged from 242 ppM near a heavily used bridge to 4 ppM near the major tributary of the lake. A simple compartment model accounts for some of the interchanges between dissolved and particulate forms of Pb through the processes of adsorption, absorption, and complexation. The time required to achieve steady-state conditions for the model is comparable to the yearly flushing period. Large shifts in the annual timing of flushing and mixing are encountered because of meteorological changes.

38096 Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977). 664p. (CONF-770325—).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

Separate abstracts were prepared for the 122 papers presented at the conference. (HLW)

38097 Estimating the potential for future oil spills from tankers, offshore development, and onshore pipelines. Beyer, A.H. (Chevron Oil Field Research Co., La Habra, CA); Painter, L.J. pp 21-30 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

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This paper summarizes historical spill statistics and describes techniques and equations that can be used to predict possible future oil spillage from marine tankers, offshore petroleum development facilities, and cross-country pipelines. These techniques would be expected to provide worst-case estimates because they do not account for continuing improvements in technology, operating procedures and safety measures. Information compiled from the literature on world-wide tanker casualty spills during 1969-1972 indicates that such spills can be expected to occur within 50 miles of land an average of once in every 1,000 vessel port-calls or about once in every 50 vessel-years of operation. The average size of these casualty spills (within 50 miles of land) is 7,100 bbl and the average spill rate is about 87 bpmb (bbl per million bbl) transported. Oil spill data from the U.S. Geological Survey are presented for outer continental shelf (OCS) petroleum development operations during 1966-1975. This information indicates an average spill rate from all causes (pipeline accidents, blowouts, fires, etc.) of about 72 bpmb produced. Oil industry cross-country pipeline spill data for Western Europe (1968-1974) and Canada (1965-1972) show that 1.1 to 1.5 spills can be expected from all causes per year per 1,000 miles of pipeline. The mean spill rate (obtained for Western Europe only) was 3.6 bpmb of throughput.

38098 Model for the costing of oil spill clearance operations at sea. Holmes, P.D. (British Petroleum Co., Ltd., London). pp 39-44 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

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Analysis of published data reveals that the total costs attributable to an oil spill are made up of a number of components which include the actual costs of the cleanup operations by government and/or industry (incurred either directly or through a contractor), third party costs (compensation to fishermen, boat-owners, etc.) and miscellaneous costs, including legal expenses, administrative charges, and fines. The relative proportions of each component vary considerably depending on the particular circumstances and location of each spill. Costs generally fall into three groups defined broadly as offshore (low costs per ton oil spilled), inshore and onshore (high costs per ton oil). Considering only the costs of cleanup operations, a model has been developed for estimating the cleanup costs for various situations (offshore, inshore and onshore) and using different cleanup techniques (recovery, dispersion, absorbents, etc.). This model takes into account the spill size, makes allowance for transport time and allows for the practical effects of natural dispersion, evaporation, etc. Use is made of the model to calculate costs for typical situations using practical component cost data to show the

optimum conditions for each method of treatment and to show the dependence of recovery or dispersant operations on spill size.

38099 SLIKTRAK: a computer simulation of offshore oil spills, cleanup, effects and associated costs. Blaikley, D.R. (Amoco Europe/E and P Forum, London); Dietzel, G.F.L.; Glass, A.W.; van Kleef, P.J. pp 45-52 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

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The reasons are introduced for the development of a simulator sufficiently simple to enable weather data normally acquired for E and P operations to be used. "SLIKTRAK," developed by Shell, applies a slick description and combat concept, developed within the E and P Forum for well blowouts in the North Sea, but applicable to other areas. This concept includes costs for cleanup, damages and the effect of phenomena such as evaporation and natural dispersion. These factors are based on industry experience and vary primarily with sea conditions. The computer program stimulates the continued creation of an oil spill and applies weather data to predict movements of each day's spillage for successive days at sea and quantities of oil left after each day until the oil either disappears or reaches a coastline. Cumulative probability curves for the oil volumes cleaned up, oil arriving at specified shores, total costs, etc., are produced by random selection of input variables such as well location, weather data, the possibility of well bridging etc., and repetition of simulated spill incidents over a large number of cycles. Trace-plots of individual spills may also be generated. In association with the E and P Forum's position as technical advisers to the North West European Civil Liability Convention for Oil Pollution Damage from Offshore Operations, a study based on the North Sea areas has been made. These results and further developments of the program are discussed.

38100 U.S. Navy R and D efforts in support of oil pollution abatement strategies. Hura, M. (Naval Material Command, Washington, DC); Finger, S. pp 61-63 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

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The Navy has become increasingly concerned with the detrimental environmental effects which may result from the oily waste discharges and oil spills from its ships and shore facilities. The Navy has embarked on a vigorous oil pollution abatement program designed to permit its ships and shore facilities to at least meet existing federal, state, and local environmental regulations. The basic strategy of the program has been to institute measures that will reduce the amount of oil being discharged into the environment wherever possible, before implementing oily waste treatment techniques. In implementing the oil pollution abatement program it became apparent in many instances that commercially available off-the-shelf systems were not suitable for direct Navy use. Strict space, weight, reliability and maintainability requirements associated with operational Navy units precluded, in many instances, the use of existing oil pollution abatement equipment. For these reasons, an extensive research and development program was initiated. Numerous in-house laboratories and private contractors have been actively involved in the development of a technology base required to support oil pollution abatement strategies. They have been instrumental in identifying the causes and magnitude of the problem, developing operational changes, and providing techniques and hardware to combat oil pollution. The most salient contributions of the program are shipboard oil/water separators for contaminated bilge and ballast wastes, real time oil-in-water monitors, and effluent oil spill containment and cleanup equipment.

38101 What constitutes good telecommunications systems for an oil spill cleanup. Pearce, R.B. (Standard Oil Co. of California, San Francisco). pp 69-75 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

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It can be a serious mistake to select telecommunications hardware before thoroughly considering the plan of how the cleanup team is expected to react and what it is expected to accomplish. Accordingly, team members need two specific telecommunications systems to enhance the efficiency of their reactiveness. "Operations" systems are needed to keep the on-scene cleanup team synchronized, while "logistics" systems are needed to call up and maintain an orderly flow of support materials, supplies, and equipment. Telephone systems also are essential to maintain contact with authorities and handle public relations matters. However, inasmuch as spills almost never recur in the same locations, telephone facilities for cleanup are generally nonexistent and, hence, such installations are delayed until the cleanup work is well in progress. Types of appropriate telecommunications equipment needed to support a major oil spill operation are listed. In this regard, a case example is cited, namely, the Oakland estuary oil spill of January 1973, in which the telecommunications net supported 80 supervisory team leaders and 50 subcontractors. Current costing of a desirable telecommunications network suggests that the resultant optimization of deployed manpower and equipment could be paid back in the savings of less than one day's cleanup operations at the site of a major oil spill.

38102 Dynamic international contingency plan. Corbett, C.R. (Coast Guard, Cleveland); Beckett, C.J. pp 79-80 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

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The mere development of a pollution contingency plan will not provide for adequate, and certainly not ideal, organizational response to a spill unless it is coupled with a conscious and deliberate effort by cognizant agencies and people to communicate with and to know each other. A practical method of eliminating organizational problems while at the same time improving operational capabilities is to identify specialized projects which will involve all concerned with the plan and response. This paper tells of an international contingency plan and how its parties from Canada and the United States approached this problem when a major oil spill occurred in the St. Lawrence River on June 23, 1976.

38103 St. Lawrence River oil spill of June 23, 1976: are you ever truly ready. Foley, J.P. (Coast Guard, Buffalo); Tresidder, S.J. pp 81-85 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

On June 23, 1976, tank barge Nepco 140 grounded near the eastern end of Wellesley Island releasing approximately 300,000 gallons of No. 6 oil into the St. Lawrence River. Over the following three days the oil spread 85 miles downstream and contaminated more than 300 miles of island and mainland shoreline. The cleanup lasted more than 16 weeks at a cost of more that $8 million. The need to reduce the affected area should be paramount to all other considerations in a spill such as this. The problems encountered in this spill should clearly motivate both government agencies and private concerns to plan for and provide all that is necessary to be as prepared as possible for an incident of this nature. In this case study, the inability to mitigate the damage resulted not only in a time consuming and expensive cleanup, but in contamination to high residential development, wilderness shoreline, wildlife refuges and marshland frontage. Previous incidents in similar areas did not provide complete information for pre-planning as to the behavior of the oil. When technology and nature may not allow meaningful containment, it is essential that the pre-designated on-scene coordinator (OSC) implement an organizational scheme to make the recovery effort as effective and as thorough as possible. Where environmental and economic impacts are severe, it is necessary for the OSC to have planned both internal organizational needs and substantive needs for the physical recovery itself. The comments in this paper point out an approach which was successful on the St. Lawrence River.

38104 Contingency planning for the impact of oil spills in different coastal environments of Canada. Owens, E.H. (Louisiana State Univ., Baton Rouge). pp 115-122 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

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Planning for a cleanup operation of the shore zone requires consideration of the physical nature of the coast (including the sediment types), wave energy levels, and tidal range. Beaches exist in a dynamic state and are continuously changing in response to littoral processes. In addition to these temporal variations, there is frequently considerable variability of shoreline types and process characteristics within a small region. In eastern Canada, contingency planning must cover rocky shorelines, sand beaches, and muddy coasts. There also is a wide range of littoral process environments, from the exposed Atlantic coast to the sheltered Bay of Fundy, which has tidal ranges on the order of 10 to 15 meters. Three examples from eastern Canada illustrate the variability of shorelines and processes in the context of cleanup planning.

38105 Light scattering techniques for discriminating between oil and particulates in contaminated water. Friedman, B. (Taylor Naval Ship Research and Development Center, Annapolis). pp 153-156 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

Light scattering techniques are used in several oil-in-water monitors, proposed or in existence. Particulate matter which may interfere with these monitors is also frequently found in oily wastes. An analysis is made of the potential of using measurements of the angular intensity distribution of scattered light in conjunction with determination of the state of polarization of the scattered light for discriminating between oil and particulates. The size conditions which apply to the oil droplets and particulates relative to the incident light allow the scattered light angular intensity distribution to be treated as a consequence of a combination of classical diffraction and of geometrical refraction and reflection. The state of polarization of the scattered light for oil droplets is investigated using expressions for the electric field which are approximations to the expressions of the Mie theory. For the particulate matter, the state of polarization is probed on the basis of light reflected from a plane. It is found that it would be difficult to discriminate between oil and particulates using measurements of the angular intensity distribution of scattered light even in conjunction with the determination of the state of polarization of the scattered light in a real life situation.

38106 Development and test of a shipboard, continuous, on-line oil-in-water content monitor using forward (laser) light-scattering techniques. Batutis, E.F. (General Electric Co., Philadelphia); Skewes, R.L. pp 157-160 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

This paper describes the procedures and results of a U.S. Coast Guard funded program (Contract No. DOT-CG-32370-A) to evaluate the capabilities of a shipboard oil-in-water content monitoring spproach developed by General Electric Company. The operating principles and possible engineering model designs will be described. The results of a demonstration test program evaluating the detection principle against a wide variety of parameters will be presented. The parameters include varied concentrations of different oil types and mixtures, effects of dirt and detergent, and oil droplet sizes, as well as varied salinities and temperatures. The results of this program will show that the concept used has been able to detect 0-100 ppM of a wide variety of oils and mixtures with a response time of less than 10 seconds with each step change in the flowing stream. The response was linear and repeatable in spite of most interferences. The signal intensity was affected by certain interferences which have been isolated and for which solutions are given. Current status of the development of the forward light-scattering principle as applied to oil-in-water detection will be presented.

38107 Monitoring oil content in shipboard waste water discharges by use of a multi-phased dye transfer process. Ricci, R.J.; Kelley, A.M. (INTEX Inc., Chevy Chase, MD). pp 161-163 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

In order to meet the monitoring requirements to control the oil content in ship waste water discharges, the United States Navy has developed a new methodology for measuring oil in water over the range of 1 to 200 ppM. This new technique offers an instrument which is reliable, low-cost, small in physical size, and accurate even in the presence of solids, detergents, and other contaminants while relatively independent of the type of oil. A portable shipboard unit employing this technique has been designed and constructed and is currently under evaluation by the U.S. Navy. The multiphasic oil-in-water measurement process offers significant advantages in reliability and operational simplicity and points the way to hardware development in two classes: (1) a hand-portable, semi-automatic system for field or occasional shipboard use; and (2) a fully-automatic and continuous monitoring system capable of telemetering contamination information at preset alarm levels.

38108 Experience in monitoring the oil content of ballast water being discharged by tankers. Fleming, K. (Shell International Marine Ltd., London); Dick, J.P.P. pp 165-168 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

The main practical features required of a shipboard monitoring system are outlined. A description is given of the Societe d' Etude et de Realisation d'Equipementes Speciaux (SERES) Directe Response Ultra-Rapide (DRUR) Type I oil content monitor and its installation onboard. Typical practical experience in monitoring tanker effluents is reviewed and some of the problems experienced, mainly with the sampling system, are highlighted. Practical experience then is discussed with regard to compliance with the 1973 International Convention for the Prevention of Pollution from Ships.

38109 Quantification of Navy oils in detergent laden waters. Yu, T.S. (Taylor Naval Ship Research and Development Center, Annapolis). pp 169-172 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

Accurate measurement of the concentration of oil in effluent discharged from ships is necessary so that water pollution regulations are not violated. Detergents used to clean machinery and deck surfaces aboard Navy ships often end up in bilge water and pass through gravitational and coalescence type oil/water separators. These detergents interfere in the solvent extraction and infrared (IR) spectrometry measurement technique for quantifying oil in water. They will absorb the IR energy at the wavelength used in quantifying oil; therefore, a method which can remove such interference, yet accurately measure the concentration of oil in water, is needed. A technique of eluting the solvent extract through silica gel removed most of this interference. Aqueous samples containing Navy oils and a non-ionic detergent in concentrations up to 1000 milligrams per liter were used to evaluate this technique. The solvent extract of these aqueous samples was filtered through silica gel and the IR absorbance of the effluent at 2,930 reciprocal centimeters was measured. The results demonstrated that this technique can yield the true concentration of oil in detergent laden water as long as the ratio of the concentration of detergent to oil is less than 10 to one. This technique can also be applied to quantify oil in water that does not contain detergent.

38110 Biogenic hydrocarbons in intertidal communities. Zsolnay, A. (Duke Univ. Marine Lab., Beaufort, NC); Maynard, N.G.; Gebelein, C.D. pp 173-177 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

The biogenic hydrocarbon content was monitored from October 1974 through April 1976 at six different sites on Bermuda. Organisms from both the intertidal area and from tide pools were collected. Samples were extracted with Sohxleth, saponified, cleaned up with liquid-solid chromatography, and injected into a gas-liquid chromatograph (GLC). Hydrocarbons that produced peaks on the GLC that were considerably greater than the general background of petrogenic peaks were considered to be biogenic. A total of 84 samples of macro-algae and algal mats were analyzed. An overall mean of 33.5 μg/g of biogenic hydrocarbons to wet weight of organisms was found. From the invertebrate fauna, a total of 133 samples were taken. The barnacle, Chthamalus stellatus, had the very high mean value of 108.0 μg/g (wet weight). However, the other invertebrates had a significantly lower mean of 10.5 μg/g. It was not yet possible to ascertain from the data whether the fauna was synthesizing its own hydrocarbon material or whether it was simply incorporating the material from its food source. Of the biogenic hydrocarbons, 21 occurred five or more times. Their Kovat's Indices for an OV-101 column are given. N-penadecane and n-heptadecane were the most abundant. Pristane was never present as a possible biogenic compound.

38111 Petroleum and anthropogenic influence on the composition of sediments from the Southern California bight. Reed, W.E. (Univ. of California, Los Angeles); Kaplan, I.R.; Sandstrom, M.; Mankiewicz, P. pp 183-188 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

Low to high concentrations of petroleum hydrocarbons and industrial chemicals (polyphenyl ether, polychlorinated biphenyls, DDE; phthalates, adipates) have been detected in nearly all benthic and sandy intertidal sediment samples collected from the Southern

California borderland. Low levels of petroleum contamination in combination with recent biogenic contributions were interpreted primarily on the basis of fully-saturated cycloalkanes in the absence of cyclic alkenes, the presence of a gas chromatographically-unresolved baseline envelope, and the presence of an homologous series of alkyl aromatic hydrocarbons. The inner basins of the Southern California Bight exhibit higher concentrations of weathered petroleum than either the farther offshore basins, or the sandy intertidal zone. Near Tanner-Cortez banks and in the San Nicolas Basin, sediments appear to contain unweathered petroleum and high levels of anthropogenic chemicals. The possible sources of hydrocarbons found in the Southern California borderland sediments, in addition to shipping losses and harbor traffic, include municipal and industrial waste waters, as well as previously-undetected submarine oil seeps, submarine chemical dumps, and geochemically-mature, organic-rich Tertiary shales.

38112 Coast Guard's forensic oil identification system. Clow, J.C. (Coast Guard, Washington, DC). pp 189-191 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

The Federal Water Pollution Control Act (FWPCA), as amended in 1972, tasks the Coast Guard with development of "procedures and techniques to be employed in identifying . . . oil and hazardous substances . . . ." In carrying out this portion of the service's environmental mandate, the Coast Guard Research and Development Center has developed first generation laboratory and field systems for the forensic identification and classification of oil spills. The laboratory system utilizes four independent analytical techniques (infrared and fluorescence spectroscopy, gas and thin-layer chromatography) to match spill samples with suspected sources, while the field system utilizes two analytical techniques (fluorescence spectroscopy and thin-layer chromatography). The field system is designed to give each Captain of the Port or Marine Safety Office the capability to rapidly identify the source of the majority of oil spills, or in more difficult cases to provide sufficient information to justify the collection of additional samples for more detailed analysis by the laboratory system.

38113 Feasibility of continuous monitoring for oil pollution across channels and rivers. Rambie, G.S. Jr. (Rambie, Inc., Irving, TX); Morgan, R.H.; Jones, D.R. pp 193-196 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

Hydrocarbon-on-water monitors are useful to help control surface water pollution. The bistatic active infrared scanning oil sensor which is described could increase point monitoring (typical of most contemporary monitors) to a narrow area that can be about 900 ft long when the transmitter and receiver are mounted on towers 100 ft tall and separated by 1,500 ft. The dimensions can be scaled down with consequent improvements in performance. A modified production model of an active infrared monostatic oil sensor was used in laboratory tests to determine the spectral reflectance signatures of hydrocarbons and water at 3.4 and 3.8 micrometers wavelengths as a function of bistatic angle, with and without water waves. It was found that the signatures of all the hydrocarbons (six different types) were almost identical and uniquely different from water at bistatic angles up to 85 degrees with respect to the water surface normal. Proper operations of the scanning oil sensor requires that water have a wavy surface. The theoretical requirements for waves and the experimental results were in close agreement.

38114 Detection and mapping of oil on a marshy area by a remote luminescent sensor. McFarlane, C. (Environmental Monitoring and Support Lab., Las Vegas, NV); Watson, R.D. pp 197-201 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

Airborne remote sensing can be a cost-effective method for monitoring pollutants in large areas such as occur in oil spills. An opportunity to test a particular method arose when a well ruptured and for 23 days spewed a 90-meter fountain of oil into the air, dispersing the oil over a wide area. The method tested was an airborne luminescence detector with a Fraunhofer Line Discriminator (FLD) which was flown over the affected area 41 days after the well was capped to obtain a map of the deposition pattern. To calibrate the system, samples of Spartina (wire grass) and Phragmites (common reed) were collected from the contaminated area and the oil residues were eluted in cyclohexane and quantitatively analyzed in a fluorescence photometer. Good correlation was observed between the remote sensor (FLD) and the laboratory analysis. Isopleths defining the deposition pattern of oil were drawn from the remote sensing information. A discussion will be presented on the feasibility of using this instrument for similar contamination incidents for cleanup and damage assessment.

38115 Comparative evaluation of real and synthetic aperture radars for the detection of oil pollution in the Santa Barbara channel. Kraus, S.P. (Univ. of California, Santa Barbara); Estes, J.E.; Vollmers, R.R. pp 203-208 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

The Coast Guard, in cooperation with the U.S. Army, Motorola Government Electronics Division, Naval Research Laboratory (NRL), and University of California, Santa Barbara Geography Remote Sensing Unit (GRSU), conducted a series of controlled tests off southern California during May 1976 to evaluate the oil detection and surface target sensing capabilities of two Motorola developed side-looking radars—a real aperture AN/APS-94D and a synthetic aperture coherent-on-receive (COR). Targets imaged during the coincident overflights included: natural oil seepage, NRL induced simulated oil spills, oil production platforms, piers, mooring buoys, commercial boats and barges, small pleasure craft, and coastal kelp beds. These overflights represented one of the few recorded instances where real and synthetic aperture radars were flown together and perhaps the first time two such systems had operated concurrently over water. Based on an analysis of imagery from the 10 coincident radar runs, COR provided better detection of natural and man-made oil slicks, while the APS-94D consistently exhibited higher surface target resolution results.

38116 Current applications of remote oil monitoring equipment. Wright, J.A. (Wright and Wright, Inc., Newton, MA). pp 209-210 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

Industrial field experience has shown that remote single-point monitoring of the surface of wastewater streams using an infrared reflectance instrument is an effective method of detecting oil films associated with oil in water concentrations as low as one part per million (ppM) in turbulent flow patterns. Four operational case histories of installations in petroleum refineries and manufacturing plants illustrate the application of an infrared oil film monitor.

38117 Satellite sentinel for oil spills in 1978. Hovis, W.A. (National Oceanic and Atmospheric Administration, Washington, DC); Jones, D.R. pp 211-213 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

Existent NASA and National Oceanic and Atmospheric Administration (NOAA) satellite sensors are optimized for the viewing of high reflectivity atmospheric phenomena and land features. Thus, detection of surface pollutants or color differences in low reflectivity sea or fresh water is marginal at best. A few suspected oil spill sightings have been made by the NASA satellites Landsat 1 and 2 but their infrequent (once in every 18 days) orbital overpass precludes their use for detecting and monitoring oil spills on a daily basis. This paper describes the oil spill detection and monitoring capability of the Coastal Zone Color Scanner (CZCS), a six spectral band scanner specifically designed for ocean color imagery to fly on Nimbus G in 1978. NASA U-2 high altitude flights with a CZCS breadboard scanner onboard have demonstrated a capacity for detecting the natural oil seepage off the coast of Santa Barbara, California. The results will be described in terms of the satellite's capability to detect oil pollution of this relatively small magnitude or larger on a near daily global basis.

38118 U.S. Coast Guard Airborne Oil Surveillance System status report. Maurer, A.T. (Coast Guard, Washington, DC); Edgerton, A.T.; Meeks, D.C. pp 215-219 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

Evaluation of a U.S. Coast Guard prototype operational airborne coastal patrol system has been completed. The prototype system has proven effective for detection, monitoring, and assessment of offshore oil discharges; search and rescue operations; ice reconnaissance; and monitoring of foreign fishing activities in coastal waters. The system combines several sensors (side-looking radar, IR/UV line scanner, camera and passive microwave imager) with a real-time display system for effective operation around the clock and under all but extreme weather conditions. The Coast Guard subsequently contracted with Aerojet ElectroSystems Company to modify the sensor equipment for installation in a C-130 aircraft for operational deployment. Active operations using the modified system are scheduled to begin in January 1977. This paper describes the results of prototype operational evaluation, the operational configuration of the C-130 system, and the future plans for the system.

38119 Biological criteria for the selection of cleanup techniques in salt marshes. Westree, B. (URS Research Co., San Mateo, CA). pp 231-235 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

During the removal of oil spills in salt marshes, intensive application of manpower and/or equipment may result in physical abuse and injury to the salt marsh far in excess of that caused by the oil itself. Physical characteristics of a salt marsh dictate the distribution and behavior of oil in the marsh. The salt marshes of the United States were grouped into categories based on their physical characteristics. The biological features of each marsh category most sensitive to oil contamination and state-of-the-art cleanup technology were identified. Types and degrees of effect of oils were similarly categorized. Techniques for cleanup were compared to the behavior of uncontained oil in the marsh and the potential for damage evaluated. Degrees of damage were compared and least damaging cleanup strategies selected.

38120 Some studies of an oil spillage due to the Jacob Maersk accident. Canelas, L.D.; Calejo Monteiro, J.D. (Gabinete da Area de Sines, Lisbon). pp 281-288 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

The introduction of oil into the hydrosphere subjects it to several transformation processes, as a consequence of the different environmental conditions which may alter its composition. These modifications include evaporation, solution and dispersion, oxidation (other chemical alterations), microbial decomposition, absorption by biota and sedimentation. The Jacob Maersk accident taking place at Leixoes harbor on January 29, 1975, seemed not to have catastrophic consequences when compared to similar accidents. However, only after a long time will it be possible to estimate the influence of the different fractions of oil, as well as the dispersants and detergents used on biotic communities. Studies still are being conducted in that area of the behavior of populations due to the impact and of the ecological recuperation of the community structure. It should be emphasized that the use of dispersant began January 31. 160 barrels were used on February 2. Trawler ships applied the dispersant at a rate of four barrels/hour, using pressure hoses, as well as one spray system. The dispersant application—about 2,000 barrels of 200 liters each were used by mid-March—was by "FINA" technicians. Two dispersion processes were used: emulsification at 4% with water and subsequent distribution with fire monitors, and distribution of product by sprinklers and subsequent mixing with high pressure nozzles. It was the aim of the present work to obtain somee experience in order to collect the most information from such situations. This represents a preliminary survey carried out during several months on the accident site, and to be continued later by the responsible entities.

38121 Sinking of tanker St. Peter off Colombia. Hayes, T.M. (Canadian Coast Guard, Dartmouth, Nova Scotia). pp 289-291 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

The tanker St. Peter sank on February 5, 1976 in 1,000 meters of water approximately 30 kilometers off Cabo Manglares, Colombia. The author was assigned on behalf of the Intergovernmental Maritime Consultative Organization (IMCO) to provide technical advice to the Colombian and Ecuadorian governments regarding countermeasures against pollution. The lack of locally available equipment to locate the vessel and eliminate the source, the logistics involved in mounting operations to reduce the environmental damage, and the need for a response organization are discussed. A particular problem was finding equipment which could operate at the extreme depths and developing a plan for removing the long-term pollution threat, the crude oil cargo.

38122 Oil slick spreading beneath a uniform ice cover in the presence of a current. Weiskopf, F.B.; Uzuner, M.S. (ARCTEC, Inc., Columbia, MD). pp 297-300 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

Previous studies of oil spreading rates conducted in still water or on solid ice cover predicted several different spreading phases which involved gravity, inertia, viscous and surface tension forces. The purpose of this study was to analyze the effects of a steady current of water on the movement of an oil slick beneath a smooth uniform ice cover. The analysis of these tests, which were conducted on both a crude oil and No. 2 fuel oil, indicated that an additional spreading phase occurs in the presence of a current. This additional spreading phase was controlled by a balance between the drag of the water on the oil slick and the retarding force of the ice sheet on the oil slick. Based on the data obtained in the test program, equations were developed for predicting the spreading of these oils beneath a uniform ice cover in the presence of a current. The results of this investigation are applicable to natural underwater oil seepage, oil well leakage, underwater pipeline leakage, and vessel rupture in oceans or rivers having ice cover.

38123 Oil pollution in the Mediterranean Sea. Le Lourd, P. (Regional Oil Combating Center for the Mediterranean, Manoel Island, Malta). *Ambio;* 6: No. 6, 317-320(1977).

Sources of oil pollution in the Mediterranean Sea are discussed and an attempt is made to evaluate the input, taking into account the general characteristics of oil transportation in this area. The oil pollution situation and its consequences for the marine environment are examined. Finally, remedial solutions and planned measures are considered, with particular reference to the UNEP Action Plan.

38124 State of pollution of the Mediterranean Sea. Osterberg, C.; Kecks, S. *Ambio;* 6: No. 6, 321-326(1977).

Because of its configuration and proximity to a number of more developed nations, the Mediterranean is expected to be one of the first seas to suffer harm from man's impact. An overview of the major pollutants impinging on the Mediterranean is presented, and some judgements are made of their relative importance. Although fringes of the sea are polluted, particularly in the northwest basin, the levels of most pollutants in the open sea are similar to those in other oceans. Sewage and oil pollution appear to be the principal problem.

38125 Pollutants from land-based sources in the Mediterranean. Helmer, R. (World Health Organization, Geneva). *Ambio;* 6: No. 6, 312-316(1977).

An inventory of pollution sources was established and an assessment of total pollution loads was made under a UNEP project implemented jointly by six UN agencies. Municipalities, industry, agricultural runoff, river inputs and nuclear installations were considered in the source evaluation study. Results and findings of this project are presented in a summarized form and conclusions drawn as regards the proportionate contribution of each pollution source.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 37008, 37996, 37998, 37999, 38000, 38001, 38002, 38018, 38062, 38071

WATER

REFER ALSO TO CITATION(S) 36986, 37756, 38125

AQUATIC ECOSYSTEMS AND FOOD CHAINS

REFER ALSO TO CITATION(S) 38071

THERMAL EFFLUENTS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 38058

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 38046

38126 Calcium carbonate production of the mare incognitum, the upper windward reef slope, at Enewetak Atoll. Smith, S.V.; Harrison, J.T. (Univ. of Hawaii, Kaneohe). *Science;* **197**: No. 4303, 556-559(5 Aug 1977).

Corals and algal pavement produce calcium carbonate more slowly on the windward reef slope of Enewetak Atoll than on the reef flat despite the high standing crop of reef-building organisms on the slope. The capacity of reefs to remain at or near sea level is therefore not determined primarily by growth on the seaward slope.

REGULATIONS

REFER ALSO TO CITATION(S) 36807, 36836, 36838, 36839, 36991, 37595, 38006, 38007

38127 IMCO and the evolving international scheme for controlling marine pollution. Schubert, F.P. (Coast Guard, Washington, DC). pp 3-6 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

This paper describes the genesis, composition, and functions of the Intergovernmental Maritime Consultative Organization (IMCO) and the expanding role of this United Nations specialized agency in protection of the marine environment. Focusing on the work of IMCO's Marine Environment Protection Committee (MEPC) established in the wake of the 1973 Marine Pollution Conference, the paper gives evidence of the universal concern for the oceans in the nature and scope of the family of international conventions developed under the auspices of IMCO. Also discussed is the extent to which U.S. regulations on prevention, control of, and response to marine pollution are looked at as models for international standards and, conversely, how IMCO-related activities bear upon U.S. regulations in this field. As the primary U.S. maritime regulatory and enforcement agency, the Coast Guard plays a leading role in IMCO affairs, particularly those concerned with the prevention of marine pollution. Its role in providing assistance to other IMCO member nations also is described, as are methods for mutual sharing of the latest techniques and methodologies for the prevention, control of, and response to pollution incidents.

38128 International regulation of the tanker industry. Gray, W.O.; Carven, C.J.; Becker, G.L. (Exxon Corp., New York). pp 7-10 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

Viewpoints regarding the effectiveness of international regulations for safety of ships and crews and for pollution prevention cover a broad spectrum. The authors believe that the basic framework for effective and enforceable regulations to control safety and protect the environment already exists in a "family" of IMCO (Intergovernmental Maritime Consultative Organization) conventions, supplemented by voluntary industry programs. Though many individual elements are not yet in force, the nations of the world have before them the opportunity to implement this coordinated set of measures, thereby taking a major step toward achieving the safety and environmental protection which all desire. Alternate, fragmented, nation-by-nation approaches promise to produce only a mosaic of conflicting requirements which could undermine the efficient international flow of oil. It is the authors' hope to stimulate support for the "family" of IMCO conventions and related industry measures. Description of industry activities is believed to support their belief that responsible tanker owners are vitally concerned, not only with safe and environmentally acceptable operation of their own tankers, but also with the implementation of effective, enforceable international regulations to assure that all ships adhere to uniform standards.

38129 Controlling pollution of the marine environment: an economic analysis. Epple, D. (Carnegie-Mellon Univ., Pittsburgh); Visscher, M.; Wallace, W.A.; Wilkinson, J.W. pp 31-34 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

Although federal legislation restricts the discharge of oil and other hazardous substances into inland and coastal waterways, debate continues over the best choice of institutional arrangements to control waterway pollution through regulations, standards, penalties and cleanup charges. No one approach is necessarily best in all situations. Issues addressed when determining public policy must be concerned with the tradeoff between methods chosen to influence polluter behavior and the cost of their enforcement. Using data from the U.S. Coast Guard's Pollution Incident Reporting System (PIRS) and the Port Safety and Security/Marine Environmental Protection Quarterly Activities Report, this paper examines a model describing the behavior of polluters in response to pollution control costs and, in so doing, stresses the potential economic impact. Implications for public policy also are presented.

38130 Problems and perspectives in recovery of oil pollution removal costs. Norris, W.H.; Johnston, H.N. (Coast Guard, Washington, DC). pp 35-38 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

The paper examines Sections 311(f), and (i) of the Federal Water Pollution Control Act (FWPCA) and discusses the statutory scheme for the recovery of clean-up costs by both the government and private persons. Legislative intent then is compared with actual practice and experience as reflected in statistics developed from the Coast Guard's Pollution Incident Reporting System (PIRS) data and the records used in administering the revolving fund. Actual case histories are used as a means of discussing the legal problems involved in administering sections 311(f) and (i). Government practice and case law are examined wherever appropriate, including recovery under 311(f) when government liability is at issue; recovery when both an owner/operator and a third-party are involved; recovery by the government from CRISTAL and TOVALOP; and practice in the Court of Claims under section 311(i). The paper concludes with a brief comment concerning the comprehensive oil spill liability bill (H.R. 14862), introduced in the 94th Congress, which would provide for an unlimited, readily accessible cleanup fund by imposing a per-barrel fee on oil as it is received at the refinery or transport terminal.

ENVIRONMENTAL-SOCIAL ASPECTS OF ENERGY TECHNOLOGIES

SOCIAL AND ECONOMIC STUDIES

REFER ALSO TO CITATION(S) 37510, 37536, 37555, 38098, 38099, 38129, 38130

38131 Recovering for marine life damage: legal aspects of allocating social costs and protecting public interests. Lutz, R.E. II (McGeorge School of Law, Sacramento, CA); Meck, J.P. pp 11-14 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

Determining and evaluating wildlife damage is becoming a necessary procedure in the settlement or adjudication of harm resulting from major oil spills. This is especially so in light of the several present and the many proposed compensation funds which provide for wildlife damage. Once a dollar figure is ascertained, various methods are available in compensating for these damages. In determining damages, two basic problems exist. First is the question of who owns the wildlife or who can assert a claim to ownership of the wildlife. Second, how can the fact and extent of damage to wildlife be assessed. The various theories supporting the right to wildlife damage recovery include: ownership in fee, trusteeship, parens patriae, public interest/private Attorney General, and citizen-guardian ad litem. Ascertaining the fact and extent of damages must be reasonably certain and not speculative. Such certainty can be determined from statistical estimations based on adequate sampling or inventories. Wildlife damage resulting from a major oil spill can amount to many millions of dollars. Arriving at the final figure in most instances necessitates addressing two issues: one, placing a dollar figure on wildlife species having no current market value; two, calculating the damage of the destroyed wildlife in the context of the relevant ecosystem. Methods of evaluating currently non-

marketable natural resources and damage to relevant ecosystems include replacement value, psychic value, and consumptive and non-consumptive use values.

38132 Oil spill liability and compensation (Superfund). Reynolds, J.J. (American Inst. of Merchant Shipping, Washington, DC). pp 15-18 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

The subjects under consideration are the liability imposed upon shippers, producers, refiners, and other handlers of oil, and the compensation monies available to persons damaged from oil spills. The liability and compensation system in existence today is one that provides little or no coverage in some instances, adequate coverage in some instances, and double coverage in still other instances. It has been correctly described as a patchwork. In the past three years, concerted efforts have been made by industry, government, and environmentalists to legislate improvements to the system. An attempt to enact a comprehensive oil spill liability and compensation law made substantial progress in the last Congress. This paper reviews the system as it now exists, the problems caused by the existing system, the proposed legislative changes, and the status of the legislation today.

ASSESSMENT OF ENERGY TECHNOLOGIES

REFER ALSO TO CITATION(S) 37185, 37510, 37517, 37533, 37534, 37536, 37548, 37555

ENVIRONMENTAL IMPACT STATEMENTS

REFER ALSO TO CITATION(S) 36853, 37257

BIOMEDICAL SCIENCES, BASIC STUDIES

BEHAVIORAL BIOLOGY

38133 Avoidance response of midge larvae (Chironomus tentans) to sediments containing heavy metals. Wentsel, R.; McIntosh, A.; McCafferty, W.P.; Atchison, G.; Anderson, V. (Purdue Univ., Lafayette, IN). *Hydrobiologia ;* **55**: No. 2, 171-175(18 Aug 1977).

Avoidance reactions of chironomid larvae to contaminated sediment taken from a heavy metal impacted lake were studied. Heavy metal levels in the test sediment ranged from background of 0.6 parts per million (ppM) cadmium, 77 ppM zinc and 17 ppM chromium to a maximum of 1,029 ppM cadmium, 17,262 ppM zinc and 2,106 ppM chromium. A linear relationship was established between cadmium and zinc levels in the sediment and avoidance by chironomids. An approximate threshold avoidance of metals in the sediment was determined to be between 213 and 422 ppM cadmium, 4385 and 8330 ppM zinc and 799 and 1513 ppM chromium.

BIOCHEMISTRY

REFER ALSO TO CITATION(S) 37954, 38163, 38164, 38168, 38169, 38189, 38193, 38194, 38219, 38222

38134 (ANL—77-55, pp 149-165) **Molecular studies.** 1976.

In Division of Biological and Medical Research annual report, 1976.

Progress is reported on studies of the structure and function of biological molecules in solution, and on mechanisms of circadian regulation in simple eukaryotes and mammals. Both projects are concerned with the definition of organismic, cellular, and subcellular processes in terms of molecular changes and events. Such knowledge is especially vital for elucidation of cytotoxic, mutagenic, and carcinogenic effects of toxicants generated in nuclear and nonnuclear energy production. Among specific objectives of the first project are accurate determination of secondary and tertiary structures of key biological molecules in solution, analysis of conformational dynamics for these molecules and the effects of environmental agents thereon, and correlation of structural-conformational data with modes of biological function. Results achieved to date for nucleic acids include complete conformational descriptions for all commonly occurring ribo- and deoxyribonucleotides and for fifteen diribonucleoside monophosphates in aqueous solution at neutral pH. The central aim of the second project is to define in molecular terms the nature and commonality of circadian regulatory processes occurring across a wide range of organisms. The approaches adopted employ a variety of methods including those of comparative molecular biology and biochemistry coupled with novel circadian protocols for entrainment such as light, food, and temperature. Studies have shown that the circadian clock is a general property of free-living cells; that the circadian oscillation occurs only during infradian growth mode; that uv plays a dominant role in the action spectrum for resetting; that uv resetting is photoreactiveable; and that temporally characteristic (chronotypic) nucleic acid synthesis occurs in the circadian cell cycle.

38135 (ANL—77-55, pp 167-172) **Crystallography.** 1976.

In Division of Biological and Medical Research annual report, 1976.

Progress is reported on studies of the molecular structure of Bence-Jones proteins and other immunoglobulins using x-ray crystallographic procedures.

38136 (ANL—77-55, pp 203-209) **Molecular anatomy program.** 1976.

In Division of Biological and Medical Research annual report, 1976.

Progress is reported on the separation of subcellular organelles and comparison of constituents common to the same organelle in different tissues and different organelles in the same tissues. Results are reported from studies on a two-dimensional electrophoretic system for the separation of human plasma proteins and elucidation of changes in serum proteins induced by disease or environmental pollutants.

38137 (BNL—24012) **Enzymatic photoreactivation of DNA.** Sutherland, B.M. (Brookhaven National Lab., Upton, N.Y. (USA)). 1978. Contract EY-76-C-02-0016. 10p. (CONF-780226—7). Dep. NTIS, PC A02/MF A01.

From Symposium on DNA repair mechanisms; Keystone, CO, USA (19 Feb 1978).

The distinguishing hallmarks of photoreactivation of DNA is the enzyme-mediated, light-dependent monomerization of pyrimidine dimers resulting in repair of the DNA and restoration of its biological integrity. Photoreactivation is differentiated from sensitized dimer monomerization by small molecules by the participation of the protein macromolecule and from dimer monomerization by tryptophan-containing peptides and proteins by their wavelength dependence. The photoreactivating enzyme shows three levels of specificity: first, for the length and kinds of nucleic acid; second, for cis-syn cyclobutyl pyrimidine dimers; and third, for photoreactivating photons of wavelength 300 to 600 nm. Although all photoreactivating enzymes characterized to date show this specificity in function, current reports indicate possible heterogeneity in structure. Most PR enzymes [E. coli, T. domestica (silverfish), H. sapiens, S. griseus] are composed of a single polypeptide chain with a molecular weight of 35,000 to 40,000 d. However, the yeast enzyme is reported to be composed of two dissimilar subunits with molecular weights 60,000 and 85,000.

38138 (COO—0894-16) **Energy transfer and utilization in biological systems. Final report, September 1, 1967—September 15, 1976.** Lumry, R.W. (Minnesota Univ., Minneapolis (USA)). Mar 1978. Contract EY-76-S-02-0894. 8p. Dep. NTIS, PC A02/MF A01.

In fluorescence studies of the photosynthetic process it was shown that the photosynthetic rate and light loss via chlorophyll fluorescence are strictly complementary. The exciplex state of matter responsible for most photochemistry was discovered and a wide variety of information about the state gained from studies of indole exciplexes. In addition to the nature of the bonding, degree of stability and general excited state behavior of indole exciplexes, their ability to lose electrons in a highly temperature-dependent quenching process was established. Time resolved emission spectroscopy demonstrated that local-movement relaxation in the interior of globular proteins occurs more rapidly than 10^{-9} sec. Subsequent studies show this to be an important and general time cut-off in the conformational fluctuations which support protein function. Although a chlorophyll-chlorophyll exciplex was produced, its relevance to the System II trapping center was not established. Only recently has the exciplex nature of both System I and System II trapping centers been exposed by others.

38139 (LA—7153-MS) **Evolutionary distance and secondary structure for biomolecules.** Waterman, M.S.; Smith, T.F. (Los Alamos Scientific Lab., N.Mex. (USA)). Mar 1978. Contract W-7405-ENG-48. 23p. Dep. NTIS, PC A02/MF A01.

In this report, two algorithms from molecular biology are presented. The first algorithm gives the minimum evolutionary path

between two proteins. The second gives the minimum free energy secondary structure for an RNA. Codes are given for both algorithms along with application to elementary molecules.

38140 Modulation of the hydrocortisone induction of glycerol phosphate dehydrogenase by N^6, $O^{2'}$-dibutyryl cyclic AMP, norepinephrine, and isobutylmethylxanthine in rat brain cell cultures. Breen, G.A.M.; McGinnis, J.F.; de Vellis, J. (Univ. of California, Los Angeles). *J. Biol. Chem.;* **253**: No. 8, 2554-2562(25 Apr 1978).

(R)-(-)-Norepinephrine or N^6, $O^{2'}$-dibutyryl cyclic AMP (Bt_2cAMP) potentiated the hydrocortisone-induced specific activity of glycerol phosphate dehydrogenase (EC 1.1.1.8) in dissociated rat cerebral cell cultures. The uninduced level of the enzyme was unaffected by these agents. A phosphodiesterase inhibitor, 3-isobutyl-1-methylxanthine, potentiated the effect of both Bt_2cAMP and norepinephrine. Similarly, in the C6 rat glial tumor cell line, Bt_2cAMP, Bt_2cAMP plus 3-isobutyl-1-methylxanthine, norepinephrine plus 3-isobutyl-1-methylxanthine, and 3-isobutyl-1-methylxanthine alone increased the hydrocortisone-induced specific activity of glycerol phosphate dehydrogenase without altering the uninduced level when added together with or after the steroid hormone. However, norepinephrine was effective only when added after the steroid hormone in C6 cells. The effect of Bt_2cAMP, norepinephrine, and 3-isobutyl-1-methylxanthine appeared to be relatively specific for increasing the induced level of glycerol phosphate dehydrogenase since there was no effect of these agents on the specific activity of another soluble NAD-dependent enzyme, malate dehydrogenase, or on overall total protein synthesis. Sodium butyrate, a product of Bt_2cAMP metabolism, did not mimic the effect of Bt_2cAMP.

38141 Quaternary state of methemoglobin and its valence-hybrid. A pulse radiolysis study. Ilan, Y.A.; Samuni, A.; Chevion, M.; Czapski, G. (Hebrew Univ., Jerusalem). *J. Biol. Chem.;* **253**: No. 1, 82-86(10 Jan 1978).

Using the pulse radiolysis technique on solutions of stripped adult human methemoglobin, we found that the heme-iron within a single subunit in the tetramer was reduced to iron(II). The valence-hybrid thus formed was reacted with oxygen and with carbon monoxide. Kinetics of the reactions were studied. The effects of pH, inositol hexaphosphate, and temperature on these reactions were examined. The kinetics of the ligation of O^2 and CO were used to characterize the affinity states of the valence-hybrid and its parent methemoglobin. Our results support the description of stripped methemoglobin A as residing in an R state. In the presence of inositol hexaphosphate methemoglobin is stabilized in a T state, but it switches into a high affinity state when the pH is raised above 8.0. This structural transition was not found to coincide with the switch of spin state of the heme-iron that accompanies the ionization of water in aquomethemoglobin A.

38142 Kinetics of carbon monoxide binding to singly reduced human methemoglobin. Ho, K.; Klapper, M.H.; Dorfman, L.M. (Ohio State Univ., Columbus). *J. Biol. Chem.;* **253**: No. 1, 238-241(10 Jan 1978).

The kinetics of reaction of singly reduced methemoglobin ($HbFe_3^{3+}Fe^{2+}$) with carbon monoxide have been investigated by the pulse radiolysis method. The rate constant for carbon monoxide binding to this form of hemoglobin is $4.1 \times 10^6\ M^{-1}\ S^{-1}$ at 24° in our solutions. This value compares with existing values for various forms of hemoglobin ranging from 4×10^6 to $6.5 \times 10^6\ M^{-1}\ S^{-1}$. Addition of inositol hexaphosphate to the solutions results in a lower rate constant for carbon monoxide binding amounting to $1.1 \times 10^5\ M^{-1}\ S^{-1}$.

38143 Counterimmunoelectrophoresis in determination of prostatic acid phosphatase in human serum. Foti, A.G. (Southern California Permanente Medical Group, Los Angeles); Cooper, J.F.; Herschman, H. *Clin. Chem.;* **24**: No. 1, 140-142(Jan 1978).

We evaluated counterimmunoelectrophoresis for use in measuring prostatic acid phosphatase in detection of prostatic cancer. After staining for acid phosphatase, we could detect as little as 0.3 ng of purified enzyme standard complexed with antibody by this technique. However, when serum samples were used as antigen, the method was less sensitive (1.5-2.0 ng) because some of the serum proteins migrate with the phosphatase and decrease the intensity of the stain for acid phosphatase. For this reason we could not detect the phosphatase in serum samples of normal persons; only patients with moderately (or greater) increased activity in their serum showed positive results. In contrast, by radioimmunoassay as little as 1.0 ng of the phosphatase can be detected in serum.

38144 Chemical consequences of irradiating nucleic acids. Ward, J.F. (Univ. of California, Los Angeles). *J. Agric. Food Chem.;* **26**: No. 1, 25-28(1978).

The mechanisms by which DNA is destroyed by radiation are briefly surveyed and indicate that a large variety of products are possible. The products formed from DNA bases and from deoxyribose are discussed and mechanisms by which they could prove hazardous are summarized. It is concluded that more work is needed before any hazard can be identified.

38145 Inhibition by Concanavalin A as the basis for a specific assay of serum 5'-nucleotidase activity. Zygowicz, E.R.; Sunderman, F.W. Jr.; Horak, E.; Dooley, J.F. (Univ. of Connecticut, Farmington). *Clin. Chem.;* **23**: No. 12, 2311-2323(Dec 1977).

Concanavalin A inhibits serum 5'-nucleotidase activity, without causing significant inhibition of alkaline phosphatase activity. This observation serves as the basis for a new method for assaying the 5'-nucleotidase activity in serum, which depends upon the difference between the enzymic hydrolysis of adenosine-5'-monophosphate in the presence and absence of concanavalin A. Adenosine released by the 5'-nucleotidase reaction is deaminated by a coupled reaction with adenosine deaminase to liberate inosine and ammonia, and ammonia is measured colorimetrically by the Berthelot reaction. In sera from 40 healthy adult persons, 5'-nucleotidase activity averaged 6.4 U/liter (SD, +- 2.0; range, 3—12). In sera from 100 patients, measurements of 5'-nucleotidase activity by the new assay averaged 8% lower than by a generally accepted method in which phenyl phosphate is used to suppress hydrolysis of adenosine-5'-monophosphate by alkaline phosphatase activity. The clinical validity of the new assay was tested by measuring serum 5'-nucleotidase activities in rats with bile duct ligation and in rats treated with thioacetamide to induce heapatocellular injury.

38146 Anhydrous hydrogen fluoride deglycosylates glycoproteins. Mort, A.J.; Lamport, D.T.A. (Michigan State Univ., East Lansing). *Anal. Biochem.;* **82**: No. 2, 289-309(Oct 1977).

Exposure of glycoproteins to anhydrous hydrogen fluoride cleaves all the linkages of neutral and acidic sugars within 1 hr at 0°C while leaving peptide bonds and glycopeptide linkages of amino sugars intact. More severe treatment with anhydrous hydrogen fluoride (3 hr at 23°C) cleaves the O-glycosidic linkages of amino sugars, but peptide bonds and the N-glycosidic linkage between asparagine and N-acetylglucosamine still remain intact. Anhydrous hydrogen fluoride, therefore, may be used for the deglycosylation of glycoproteins, thereby assisting in the further purification, proteolysis, and sequencing of the protein component. During the cleavage of glycosidic linkages by anhydrous hydrogen fluoride there is little or no degradation of the sugars themselves, thus allowing their quantitative recovery. Therefore, anhydrous hydrogen fluoride may also be useful in the analysis of complex polysaccharides.

38147 Base-unpaired regions in supercoiled replicative form DNA of coliphage M13. Dasgupta, S.; Allison, D.P.; Snyder, C.E.; Mitra, S. (Oak Ridge National Lab., TN). *J. Biol. Chem.;* **252**: No. 16, 5916-5923(25 Aug 1977).

Superhelical covalently closed circular replicative form DNA (RF I) of coliphage M13 appears as a relaxed molecule that has a base-unpaired region in the form of a bubble (100 to 200 base pairs long) seen in electron micrographs when spread in the presence of formaldehyde and formamide or after pretreatment with glyoxal. S1 endonuclease, specific for single-stranded DNA, converts superhelical M13 RF I DNA, but not nonsuperhelical M13 RF I to a significant extent, into unit-length linear molecules by sequential nicking of two strands. The locations of S1 nuclease-susceptible sites and glyoxal-fixed base-unpaired regions were both related to the five A-T-rich regions in M13 RF DNA. While S1 nuclease does not show preference for any of these sites, glyoxal-fixed bubbles occur predominantly at the major A-T-rich region in M13 RF DNA.

38148 Competition for mercury between river sediment and bacteria. Ramamoorthy, S.; Springthorpe, S.; Kushner, D.J. (Univ. of Ottawa). *Bull. Environ. Contam. Toxicol.;* **17**: No. 5, 505-511(May 1977).

It was shown that bacteria compete very effectively with sediment in accumulating mercuric ions from river water. The concentrations of bacteria used in the experiments are greater than those normally found in natural waters, but not grossly so: a total of about 1.4g (dry weight) in 5.5 l of river water. From estimations of the weight per cell (about 10^{-12} g from total cell counts) it is calculated that the concentration of cells for the whole water system studied was 2.5×10^8/ml. Viable counts of 1.7×10^7/ml were found in a badly polluted arm of the Ottawa River and 2.4×10^6 in a less polluted part. Quite substantial numbers of bacteria and other microorganisms can exist in natural waters and should have a significant effect on the mobilization of mercury from the presumed "sink" (the sediment) into food chains. No evidence was obtained for any conversion to organic forms of mercury in the system used, but it seems likely that any increase in the flux of mercury would promote interconversions to organic compounds.

38149 Interruption of oncornavirus replication by modified rifamycin antibiotics. O'Connor, T.E. (National Cancer Inst., Bethesda, MD); Aldrich, C.D.; Sethi, V.S. *Ann. N.Y. Acad. Sci.;* **284**: 544-565(4 Mar 1977).

Thirteen rifamycin SV derivatives containing 3'-alkylaminomethyl substituents fail to inhibit the activities of the simian sarcoma virus Type 1 DNA polymerase, and of cellular DNA, RNA, and poly(A) polymerases prepared from NIH Swiss mouse embryos. These compounds show a range in their toxicities for NIH Swiss mouse 3T3 cells and in their capacities to inhibit production of foci of morphologically altered cells by murine sarcoma virus (MSV). Three compounds--the N-methyl-N-hydroxyethylaminomethyl, the N,N-dimethylaminomethyl, and the N^4-methylpiperazinomethyl rifamycin derivatives--are comparable to adenine arabinoside and ribavirin in their toxicity for 3T3 cells, but these compounds show superior focus inhibition. These compounds inhibit oncornavirus production apparently by exacerbation of a delay in growth that results from infection of 3T3 cells with MSV.

38150 Effect of temperature and protonation upon the conformation of 2'-O-methyladenosine; Correlation of conformational parameters in purine nucleosides. Hruska, F.E. (Univ. of Manitoba, Winnipeg); Wood, D.J.; Singh, H. *Biochim. Biophys. Acta;* **474**: 129-140(1977).

Proton magnetic resonance studies of 2'-O-methyladenosine in ^2H_2O have been carried out at variable temperature and p^{2}H. The chemical shifts and H-H coupling constants are discussed in terms of the molecular conformation. Comparison of the data with those of adenosine reveals that 2'-O-methylation has little influence on the conformation. At neutral p^{2}H where the adenine base is not protonated, the molecules favor a 2'endo, gauche—gauche conformation. Protonation of the base at the N(1) position leads to a decrease in the 2'endo, gauche—gauche bias. The data for 2'-O-methyladenosine and adenosine, as well as for several other purine derivatives, reveal the presence of a correlation between the sugar pucker and the C(5')-C(4') conformer distribution which is the inverse of the correlation previously reported for pyrimidine derivatives.

38151 Studies on cardiac myosin light chains: comparison of the sequences of cardiac and skeletal myosin LC-2. Leger, J.J.; Elzinga, M. (INSERM, Paris). *Biochem. Biophys. Res. Commun.;* **74**: No. 4, 1390-1396(1977).

Partial sequence analysis of bovine cardiac myosin LC-2 indicates that it is closely related to LC-2, the "DTNB light chain" of skeletal muscle myosin. The results suggest that myosins from a variety of sources have related light chains of two distinct types, although the sizes and properties of the light chains can vary substantially.

38152 Analysis of restriction fragments of T7 DNA and determination of molecular weights by electrophoresis in neutral and alkaline gels. McDonell, M.W.; Simon, M.N.; Studier, F.W. (Brookhaven National Lab., Upton, NY). *J. Mol. Biol.;* **110**: 119-146(1977).

The DNA of bacteriophage T7 is cut into seven unique fragments by the restriction endonuclease DpnII (or the equivalent NboI), 19 fragments by HpaI, and eight additional fragments by the combination of the two enzymes. The relative location of each fragment in the T7 DNA has been determined by a combination of techniques. If it is assumed that the length of any DNA molecule equals the sum of the lengths of the fragments produced from it by cleavage, and that electrophoretic mobility through agarose gels is a smooth function of the length of the DNA, then the known relationships between fragments provide enough conditions to define accurately the relative molecular weight of each fragment in the set. Absolute molecular weights are based on that of full-length T7 DNA. The fragments provide a convenient set of length standards covering the entire range from about 100 to 40,000 base-pairs (the length of T7 DNA). A horizontal slab gel system for electrophoresis on agarose gels is described. In this system, gels of very low concentrations do not distort during electrophoresis and accurate relative mobilities of large DNAs are obtained. Excellent resolution can be obtained for DNAs of molecular weights up to at least 26.5×10^6, a difference of less than 10% being readily resolved even for molecules of this size.

TRACER TECHNIQUES

38153 Light-driven ATP formation from ^{32}Pi by chloroplast thylakoids without detectable labeling of ADP, as measured by rapid mixing and acid quench techniques. Vinkler, C.; Rosen, G.; Boyer, P.D. (Univ. of California, Los Angeles). *J. Biol. Chem.;* **253**: No. 8, 2507-2510(25 Apr 1978).

The labeling of ATP and ADP in the first few milliseconds of exposure of chloroplast thylakoids to light, $^{32}P_i$, and ADP has been measured. At least 4 mol of ATP/mol of coupling factor 1 (CF_1)-ATPase can be formed without detectable labeling of membrane-bound or free ADP. Such results are consistent with ADP and not AMP as the primary acceptor of P_i in photophosphorylation. Evidence is presented demonstrating that quenching with perchloric acid, as used in these and earlier experiments, is satisfactory for the measurement of the amount and nature of membrane-bound nucleotides.

38154 Affinity labeling of human glucosephosphate isomerase with N-bromacetylethanolamine phosphate. Gibson, D.R. (North Texas State Univ., Denton); Talent, J.M.; Gracy, R.W.; Hartman, F.C. *Biochem. Biophys. Res. Commun.;* **78**: No. 4, 1241-1246(24 Oct 1977).

N-Bromoacetylethanolamine phosphate rapidly and irreversibly inactivates glucosephosphate isomerase in a pseudo first-order fashion. Rate-saturation effects are observed with a minimum half-life of 4.5 minutes and a half-maximal rate of inactivation at 0.056 mM. Substrates, as well as competitive inhibitors, protect the isomerase from inactivation. Using ^{14}C-labeled N-bromoacetylethanolamine phosphate, the incorporation of approximately one equivalent of inactivator per subunit of isomerase is indicated. After acid hydrolysis, the only modification appears to be the formation of carboxymethyl histidine. These studies indicate that the substrate analogue N-bromoacetylethanolamine phosphate is a specific affinity label that can be used to probe the active site of glucosephosphate isomerase.

CYTOLOGY

REFER ALSO TO CITATION(S) 37954, 38301

38155 (UCRL—52000-77-7, pp 20-26) **Flow cytometry in cervical cancer diagnosis.** Jul 1977.

In Energy and technology review.

Early detection of malignancies has, for the last 25 years, been based mainly on microscopic examination of cells taken from the anatomical site under suspicion. The Pap smear, the analysis of surface cells that can be easily scraped off the cervix, has been established as an effective technique for early detection of cervical cancer. Such cytological screening for cancers of the lung, bladder, bowel, breast, and prostate appears to be technically possible but is prohibitively expensive. We are conducting research to automate the diagnosis of cervical cancer with the goal of extending this technique to other cancers. Using the LLL multiparameter flow cytometer and cell sorter, we have been able to sort out abnormal cells based on their DNA content and cell size. However, normal cells also occur in the sorted sample, so we are searching for a third parameter to decrease their number. With this improvement, multiparameter flow cytometry will be ready for a field trial in the clinical diagnosis of cervical carcinoma.

38156 Epidermal growth factor induced membrane changes in 3T3 cells. Aharonov, A.; Vlodavsky, I.; Pruss, R.M.; Fox, C.F.; Herschman, H.R. (Univ. of California, Los Angeles). *J. Cell. Physiol.;* **95**: No. 2, 195-202(May 1978).

Epidermal growth factor (EGF) is a mitogen for Swiss 3T3 cells. Short incubation periods with physiological concentrations of EGF induced increased binding of Swiss 3T3 cells to Con A-coated nylon fibers. This effect was not induced in an EGF non-responsive 3T3 variant, in the transformed murine XC cells or in Swiss SV3T3 cells. The increase in Con A fiber-binding seems to be specific for EGF, since it was not observed in response to insulin, prostaglandin F2α or a higher serum concentration, which also initiate cell division of confluent quiescent 3T3 cells. EGF also reduced Con A-mediated hemadsorption to 3T3, but had no effect on hemadsorption by the EGF non-responsive 3T3 variant. There was no change in the number of Con A-receptors on 3T3 cells after EGF treatment. Binding to WGA-coated fibers and WGA-mediated hemadsorption were not effected by preincubation with EGF.

38157 Chromosome abnormalities in patients with hairy cell leukemia. Golomb, H.M.; Lindgren, V.; Rowley, J.D. (Univ. of Chicago). *Cancer;* **41**: No. 4, 1374-1380(Apr 1978).

We evaluated chromosomes from 20 patients with hairy cell leukemia (HCL) to ascertain the frequency and type of consistent chromosomal abnormalities. Samples from 17 patients were obtained from peripheral blood cultures grown 24 and 48 hours without phytohemagglutinin, or from bone marrow samples. Two male patients had similar, consistent abnormalities; one patient's karyotype was 46,X,+12; that of the second was 46,X,+C marker. In the latter case, the distal long arm of the C marker most closely resembled chromosome No. 12 from band q14 to q terminal, but the short arm and proximal long arm were of undetermined origin. Both karyotypes lacked the Y chromosome. A third patient had, in one sample, a single abnormal cell with an extra No. 3 and an extra No. 12 (48,XY,+3,+12), and in a later sample, a second cell of poor morphology which also could have been trisomic for No. 12. The two patients with consistent chromosome abnormalities had rapidly progressive disease and a relatively short clinical course from the time of diagnosis (5 and 7 months, respectively). Further data are needed, but the results thus far suggest that patients with consistent

chromosome abnormalities could be considered as candidates for aggressive combination chemotherapy.

38158 Kinetics of CTL introduction by Concanavalin A. Tartof, D.; Fitch, F.W. (Univ. of Chicago). *J. Immunol.;* **120**: No. 4, 1086-1091(Apr 1978).

Induction of maximal CTL activity was achieved within 12 hr of exposure to Con A in vitro in various mouse lymphoid cell populations. These included spleen cells from normal unsensitized mice, spleen cells from mice previously immunized with alloantigen, and mouse spleen cells exposed to alloantigen in long-term mixed leukocyte culture (LTMLC). Although induction of maximal incorporation of tritiated thymidine was accomplished within this same period in the cells obtained from LTMLC, a much longer period of Con A exposure (>24 hr) was required for freshly prepared spleen cells from normal or previously immunized mice. These findings indicate that the increased tritiated thymidine uptake induced in freshly prepared spleen cells on continued exposure to Con A beyond 12 hr is not associated with the development of cytolytic activity, and that it probably represents stimulation of subpopulations no longer present in the LTMLC population where positive selection for cells responsive to cellular alloantigens has taken place.

38159 Effect of molecular modification on the inhibition of lymphocyte blastogenesis by cardiac glycosides. Gordon, B.R.; Segel, G.B.; Brennan, J.K.; Lichtman, M.A. (Univ. of Rochester, NY). *Blood;* **51**: No. 3, 497-505(Mar 1978).

Cardiac glycosides are potent inhibitors of cell division. They may be useful as antitumor agents if the antimitotic effect can be dissociated from their cardiotoxic effect. We studied congeners of cardiac glycosides to determine whether the saccharide or the genin portion of the molecule contributes to its antimitotic effect. The concentration of glycoside required to inhibit PHA-stimulated ^{3}H-thymidine incorporation into DNA at 72 hr in human lymphocytes was studied. The inhibiting concentration varied by over tenfold if either the genin or the saccharide portion of the molecule was altered. Therefore either the genin or the saccharide influences independently the antimitotic effect of the glycosides. The relative inhibitory dose of specific genins or glycosides on lymphocyte blastogenesis was similar to the relative arrhythmogenic effects. Therefore development of congeners with antimitotic action but without arrhythmogenicity may be difficult. The arrhythmogenic effect of cardiac glycosides has been shown to be related to their ability to inhibit the plasma membrane Na-K ATPase of myocardial cells. The antimitotic effects parallel closely the arrhythmogenicity of individual glycosides. This relationship provides added evidence to support the concept that the antimitotic effect of glycosides is related to inhibition of Na-K ATPase. Moreover, these findings support the critical role of the transport ATPase in cell division.

38160 Human cell lines that elaborate colony-stimulating activity for the marrow cells of man and other species. DiPersio, J.F.; Brennan, J.K.; Lichtmann, M.A.; Speiser, B.L. (Univ. of Rochester, NY). *Blood;* **51**: No. 3, 507-519(Mar 1978).

We have established two human cell lines which elaborate colony-stimulating activity (CSA) for at least four species: man, mouse, rabbit, and dog. One, GCT, was isolated from a lung metastasis of a fibrous histiocytoma; the other, RC4, from a monocyte-enriched fraction of normal blood. Medium conditioned by either GCT or RC4 cells was more potent in stimulating human marrow growth in vitro than was monocyte-conditioned medium or human leukocyte feeder layers. Fractionation of cell-line-conditioned medium by Sephacryl S-200 chromatography indicated that the maximum activity of the CSA for human marrow cells eluted within the range of 30,000-40,000 daltons. These cell lines provide a continuous source of large quantities of conditioned medium for purification of CSA. Moreover, the invariable growth-supporting activity for ll species tested and the high potency of cell-line CSA facilitates studies of its elaboration and biologic effects.

38161 Concentration gradient of blood stem cells in mouse bone marrow: an open question. Maloney, M.A.; Lamela, R.A.; Dorie, M.J.; Patt, H.M. (Univ. of California, San Francisco). *Blood;* **51**: No. 3, 521-525(Mar 1978).

The distribution of pluripotential blood stem cells (CFU-S) in bone marrow was studied in four strains of mice. Analysis of paired samples containing various fractions of axial and marginal bone marrow cells, as well as longitudinal 200-μm sections, revealed a rather uniform spatial distribution of CFU-S across the diameter of the femoral medullary cavity, in contrast to the finding by others of a CFU-S concentration gradient extending from the endosteum to the central longitudinal axis of bone marrow. The existence of a stem cell gradient is therefore open to question.

38162 Kinetics and regulation of granulocyte precursors during a granulopoietic stress. Chikkappa, G.; Chanana, A.D.; Chandra, P.; Cronkite, E.P. (Brookhaven National Lab., Upton, NY). *Blood;* **50**: No. 6, 1099-1110(Dec 1977).

Studies were performed in splenectomized dogs to investigate the proliferative kinetics of the committed granulocyte-macrophage stem cells (CFU-c) and to evaluate the role of colony-stimulating factor (CSF) in the regulation of granulocytopoiesis. Eight to ten hours following intraperitoneal infusion of starch-saline, the peritoneal cavity was lavaged to remove leukocytes. Three successive lavages (I, II, and III) were done in each dog. The CFU-c concentration in the marrow cells of 4 dogs and in the blood cells of 2, obtained before, during, and after lavages, was assayed in soft-agar medium. The CSF activity of lavage fluids was measured by their ability to stimulate canine marrow cells to form granulocyte-macrophage colonies in soft-agar medium. Each lavage removed 14.6-17.5 x 10^{9} cells and the neutrophils removed were equivalent to 97%-108% of their total blood granulocyte pool. Lavaging caused rapid entry of neutrophils from the marrow into the blood and increased granulocytopoiesis in the marrow from the time of lavage II, as reflected by an increased percentage of granulocytes in the multiplicative compartment. Decreases occurred in the percentage normoblasts in the marrow commencing from the time of lavage II and in absolute reticulocyte count in blood after completion of the lavages. Marrow CFU-c decreased to a minimum (30%-57% of control value in 3 of 4 studies) at lavage I or II. CFU-c recovery with overshoot occurred in 3 of 4 studies by the time of lavage III or a day later. The pattern of blood CFU-c changes was similar to that of the marrow. CSF in lavages I, II, and III was approximately 5, 2, and 1.8 times the control level, respectively. These results suggest that during an acute need for granulocytes the marrow CFU-c differentiate under the apparent influence of CSF to form granulocytes, and pluripotent hemopoietic stem cells differentiate along the granulocytic line with a concomitant reduction in the erythrocytic line.

38163 Endogenous protein kinase inhibitor levels regulate changes in specific activity of protein kinase in quiescent cells stimulated to proliferate. Costa, M. (Univ. of Connecticut, Storrs). *Biochem. Biophys. Res. Commun.;* **78**: No. 4, 1311-1318(24 Oct 1977).

Following serum stimulation of quiescent Chinese hamster ovary cells, changes in the total specific activity of cAMP-dependent protein kinase were inversely related to the cellular levels of heat stable inhibitor(s) of this enzyme. During the initial 2 hrs. after stimulation, a rapid 2-fold decrease in the specific activity of protein kinase occurred, together with a 2-fold increase in the intracellular levels of protein kinase inhibitor(s). Similarly while protein kinase activity increased from 3 to 5 hrs, and decreased from 5 to 7 hrs. after stimulation, inhibitor(s) levels declined and then rose. These and other observations discussed below support the hypothesis that the heat stable inhibitor(s) have physiological functions in regulating the total intracellular pools of cAMP-dependent protein kinase.

38164 Heparin releases heparan sulfate from the cell surface. Kraemer, P.M. (Los Alamos Scientific Lab., NM). *Biochem. Biophys. Res. Commun.;* **78**: No. 4, 1334-1340(24 Oct 1977).

Heparan sulfate of the cell surface of cultured Chinese hamster cells (line CHO) was promptly released when the cells were incubated with balanced salt solutions containg heparin. The released heparan sulfate included multichain proteoglycan of high molecular weight. The data suggest that the cell-surface localization of heparan sulfate is dependent, at least in part, upon cell-surface receptors with binding sites for the sugar chain moieties of sulfated glycosaminoglycans.

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 38199

GENETICS

REFER ALSO TO CITATION(S) 38217

38165 (ANL—77-55, pp 189-201) **Genetics.** 1976.

In Division of Biological and Medical Research annual report, 1976.

Because DNA has a relatively simple structure, the kinds of lesions that can be produced are limited. For this reason, emphasis was placed on mechanisms of lethality and mutagenesis produced not only by environmental pollutants, but by other agents as well, because these lesions can provide vital information on common mechanisms. Bacteria were chosen for studies of molecular mechanisms of mutagenesis and lethality since good genetic maps are presently available only for these organisms. Because DNA has the same molecular structure in all plants and animals, we can assume that the same kinds of molecular mechanisms are involved in man as in microorganisms. Results are reported from studies on the produc-

tion of clustered multiple mutations by uv and strong chemical mutagens in Bacillus subtilis; mutagenesis in Escherichia coli produced by acridine orange and exposure to near ultraviolet radiation; and regulatory mechanisms for DNA repair in Bacillus subtilis.

38166 Transformation of Bacillus subtilis and Escherichia coli by a hybrid plasmid pCD1. Duncan, C.H.; Wilson, G.A.; Young, F.E. (Univ. of Rochester School of Medicine and Denistry, NY). *Gene;* **1**: 153-167(1977).

The gene thyP3 from Bacillus subtilis bacteriophage PHI 3T was cloned in the plasmid pMB9. The resulting chimeric plasmid, pCD1, is effective in transforming both Escherichia coli and Bacillus subtilis to thymine prototrophy. The activity of the thyP3 gene product, thymidylate synthetase, was assayed and found to be 9 times greater in a transformed strain of Escherichia coli than in a PHI 3T lysogen of Bacillus subtilis. The physical location of restriction sites has been determined for two related plasmids pCD1 and pCD2. Hybridization studies clearly indicate that the plasmid gene responsible for Thy^+ transformation is the gene from the bacteriophage PHI 3T. The lack of restriction in this transformation process is consistent with our previous studies using bacterial DNA in heterospecific exchanges indicating that the nucleotide sequence surrounding the gene is the dominant factor in determining interspecific transformation.

METABOLISM

REFER ALSO TO CITATION(S) 38190, 38280

38167 Relationships among arterial oxygen flow rate, oxygen binding by hemoglobin, and oxygen utilization in chronic cardiac decompensation. Daniel, A.; Cohen, J.; Lichtman, M.A.; Murphy, M.S.; Schreiner, B.F. Jr.; Shah, P.M. (Univ. of Rochester, NY). *J. Lab. Clin. Med.;* **91**: No. 4, 635-649(Apr 1978).

We have examined the interrelationships among CaO_2, blood flow, oxygen binding by hemoglobin, and VO_2 in cardiac patients with and without chronic cardiac decompensation. We have quantified the role that decreased oxygen-binding to hemoglobin may play in maintaining VO_2 in the presence of low systemic blood flow rates. The volume rate of oxygen delivery to tissues was expressed as the OFl/sub a/, the product of CO_2 and blood flow. OFl/sub a/ varied from 738 to 262 ml/min/m^2, whereas VO_2 varied from 170 to 117 ml/min/m^2. Thus, in the patients with lowest OFl/sub a/ (63% below the highest OFl/sub a/), VO_2 was only down 19%. VO_2 was maintained because the extraction of oxygen rose from about 20% to 50% in close association with the decrease in OFl/sub a/. Oxygen binding to hemoglobin was lower in patients with the lowest OFl/sub a/--and therefore, at in vivo conditions of pH, PCO_2, and temperature, P_{50} in vivo was higher. The resulting facilitation of oxygen release at the PO_2 of tissue capillaries could explain about one third of the observed increment in oxygen extraction in patients with low OFl/sub a/. An alternative interpretation is that a high P_{50} in vivo minimizes the reduction in P anti vO_2 needed to maintain VO_2 when increased proportional extraction of O_2 compensates for decreased OFl/sub a/.

MEDICINE

REFER ALSO TO CITATION(S) 37485, 37915, 37916, 37917, 38219

38168 (ANL—77-55, pp 111-117) **Liposomes as biological carriers.** 1976.

In Division of Biological and Medical Research annual report, 1976.

The advantages of using liposome encapsulation for both chelating agents and antitumor drugs were found to include: selective transport of drugs to target organs; reduction of drug toxicity to normal tissues; and increase in the therapeutic index of the drug.

38169 (ANL—77-55, pp 119-135) **Diagnosis and therapy.** 1976.

In Division of Biological and Medical Research annual report, 1976.

Progress is reported on the development of instrumentation, labeled compounds, and analytical methodology for applications of stable isotopes to biomedical and clinical problems. Collaborative studies with clinicians in the areas of gastroenterology, pediatrics, pharmacology, and gynecology are reported. Analytical resources were provided for clinicians and scientists requiring bile acid identification, quantitation, resolution, and kinetic measurements, and gas chromatography-mass spectrometry applications in clinical research and diagnosis were investigated.

38170 (CONF-771240—1) **Application of proton radiography to medical imaging.** Kramer, S.L.; Martin, R.L.; Moffett, D.R.; Colton, E. (Argonne National Lab., Ill. (USA)). Dec 1977. Contract W-31-109-ENG-38. 29p. Dep. NTIS, PC A03/MF A01.

From 1. seminar on the use of proton beams in radiation therapy; Moscow, USSR (Dec 1977).

The use of charged particles for radiographic applications has been considered for some time, but progress has been impeded by the cost and availability of suitable accelerators. However, recent developments in technology could overcome these problems. A review is presented of the physical principles leading to an improvement in mass resolution per unit of absorbed dose for charged particle radiography relative to x-ray radiography. The quantitative comparisons between x-ray and proton radiographs presented here confirm this advantage. The implications of proton radiography on cancer detection, as well as future plans for developing a proton tomographic system, are discussed.

38171 Computerized tomography apparatus with means to periodically displace radiation source. LeMay, C.A.G. (to EMI Ltd.). US Patent 4,010,370. 1 Mar 1977. Priority date 13 Nov 1974, United Kingdom of Great Britain and Northern Ireland (UK). 12p.

Radiographic apparatus is described for evaluating the absorption coefficient of a body at each of a plurality of locations distributed over a planar slice disposed cross-sectionally of the body. A source is arranged to produce a fan-shaped, planar beam of radiation which is directed through the body, in the plane of said slice, and the source is orbited around the body about an axis perpendicular to the plane of said slice. Detectors are provided, and orbited in synchronism with the orbital motion of the source, each to detect the radiation emergent from the body along a plurality of paths. In order to render the paths substantially linear despite the orbital motion, a lateral scan is imposed upon the source which is sufficient, over a predetermined time period, to substantially cancel the orbital motion and replace it by a lateral motion.

38172 Method and apparatus for scanning in computerized tomography. LeMay, C.A.G. (to EMI Ltd.). US Patent 4,010,371. 1 Mar 1977. Priority date 19 Dec 1974, United Kingdom of Great Britain and Northern Ireland (UK). 8p.

In an x-ray apparatus for examining a body source of a fan of radiation and detectors of the radiation along beams in the fan are traversed in a plane to provide data for a plurality of sets of parallel beams in the plane. An orbital motion is provided to give data for further sets at different inclinations in the plane. The data can be processed by arrangements using such "parallel" sets. The orbital motion is continuous during the traverse but the extent of angular change in one lateral scan is kept small so that lack of parallelism in the "parallel" sets does not give excessive errors.

38173 Apparatus for examining a body by means of penetrating radiation. Hounsfield, G.N.; Williams, A.M. (to EMI Ltd.). US Patent 3,999,073. 21 Dec 1976. Priority date 13 Dec 1973, United Kingdom of Great Britain and Northern Ireland (UK). 10p.

Apparatus is described for performing a computerized axial tomographic examination of a body. The apparatus contains a source of x-radiation and detector devices mounted to face one another across an opening for the body, the source being arranged to project said radiation in a plane towards the detector devices. The source and detector devices are rotated about an axis passing through said opening and means are disclosed for locating the body in said opening and for adapting the apparatus to accommodate a body which is not centrally located in said opening.

38174 X-ray table having collapsible guard rail. Conrad, R.M.; Whitcomb, C.R. US Patent 3,997,792. 14 Dec 1976. Filed date 30 Dec 1974. 4p.

An x-ray table has a cassette holder for receiving an x-ray film cassette and releasably retaining it generally adjacent to the lower surface of the table top and at least one collapsible guard rail assembly supported for movement between raised and lowered positions. The guard rail assembly includes a hollow elongated top rail supported above the plane of the table top in said raised position and disposed adjacent an associated side edge of the table top immediately above the cassette holder in said lowered position. The support members which carry each top rail and the means for retaining it in its raised position are substantially wholly disposed within the confines of the hollow top rail in its lowered or collapsed position.

38175 Neutron therapy apparatus. Colditz, J.K.E. (to U.S. Phillips Corp.). US Patent 3,995,163. 30 Nov 1976. Priority date 25 Feb 1974, Netherlands. 4p.

Thee portion of the shield of a neutron radiation apparatus which is situated nearest to the neutron source is made of tungsten. As a result, a commonly used outer shielding layer consisting of a heavy metal can be dispensed with, so that improved shielding and a substantial saving as regards weight are combined.

38176 Means for supporting an object during radiographic analysis. Workman, S.T. (to Syntex (U.S.A.) Inc.). US Patent 3,995,158. 30 Nov 1976. Filed date 15 Oct 1975. 8p.

Means for supporting an object, or a portion thereof, during radiographic analysis comprising a hollow reservoir adapted to receive and hold a constant volume of fluid material within the interior thereof, said reservoir having a pouch-like flexible member forming all or a portion of one wall thereof, said pouch-like flexible member being adapted to receive and support the object undergoing analysis during radiographic exposure thereof, a second flexible member forming all or a portion of a second wall thereof, and means operatively connected to said second flexible member for moving said second flexible member so as to cause a corresponding movement of said pouch-like flexible member. During use, the second flexible member is moved in such a manner as to cause an enlargement of the pouch-like deformation of the pouch-like flexible member. After the object to be examined is inserted in the enlarged deformation, the second flexible member is moved so as to cause the pouch-like flexible member to conform to the exterior surface of the object and thereby provide proper support therefor during the radiographic procedure.

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 37918, 37919

38177 (BNL—24112) Nuclear medicine at Brookhaven National Laboratory. Atkins, H.L. (Brookhaven National Lab., Upton, N.Y. (USA)). 1976. Contract EY-76-C-02-0016. 9p. Dep. NTIS, PC A02/MF A01.

The Nuclear Medicine Program at the Brookhaven National Laboratory seeks to develop new materials and methods for the investigation of human physiology and disease processes. Some aspects of this research are related to basic research of how radiopharmaceuticals work. Other aspects are directed toward direct applications as diagnostic agents. It is likely that cyclotron-produced positron emitting nuclides will assume greater importance in the next few years. This can be attributed to the ability to label biologically important molecules with high specific activity without affecting biological activity, using ^{11}C, ^{13}N, and ^{15}O. Large quantities of these short-lived nuclides can be administered without excessive radiation dose and newer instrumentation will permit reconstructive axial tomography, providing truly quantitative display of distribution of radioactivity. The ^{122}Xe-^{122}I generator has the potential for looking at rapid dynamic processes. Another generator, the ^{68}Ge-^{68}Ga generator produces a positron emitter for the use of those far removed from cyclotrons. The possibilities for ^{68}Ga radiopharmaceuticals are as numerous as those for /sup 99m/Tc diagnostic agents.

38178 Quantitative clinical comparison of three /sup 99m/ technetium labeled brain imaging radiopharmaceuticals. Ryerson, T.W.; Spies, S.M.; Singh, N.B.; Zeman, R.K. (Columbus Hospital, Chicago). *Radiology;* **127**: No. 2, 429-432(May 1978).

In comparison study of three commonly employed /sup 99m/Tc brain imaging pharmaceuticals, 16 patients with proven brain lesions had imaging performed with DTPA, glucoheptonate, and pertechnetate over a short interval of time. Lesion detectability was assessed by a data processing system which evaluated average lesion-to-background activity ratios for each patient examination. Statistical analysis of the resultant data demonstrated a significant improvement (20 percent) in lesion-to-background ratio in favor of one hour delayed DTPA images versus two hour delayed pertechnetate images. Comparison of one hour delayed DTPA images with one hour delayed glucoheptonate images did not reveal a significant difference in lesion-to-background ratio. The authors conclude that both Tc-DTPA and Tc-glucoheptonate are superior alternatives to pertechnetate when employed in the manner described.

38179 Cardiac chamber imaging: a comparison of red blood cells labeled with Tc-99m in vitro and in vivo. Hegge, F.N.; Hamilton, G.W.; Larson, S.M.; Ritchie, J.L.; Richards, P. (Veterans Administration Hospital, Seattle). *J. Nucl. Med.;* **19**: No. 2, 129-134(Feb 1978).

A detailed comparison was performed between the quality of cardiac images obtained using red blood cells labeled in vitro and in vivo. Both methods gave cardiac images of high quality. The in vitro method resulted in subjectively superior images, better intravascular retention of injected radioactivity, and a higher left-ventricle-to-background count ratio (p less than 0.05). The differences in image quality and left-ventricular blood-pool activity were not great, however, and the slight advantage of the in vitro method was offset by a somewhat more complicated preparative procedures. We believe that both agents are suitable for radionuclide imaging of the cardiac chambers.

38180 Normal adrenal asymmetry: explanation and interpretation. Freitas, J.E.; Thrall, J.H.; Swanson, D.P.; Rifai, A.; Beierwaltes, W.H. (Univ. of Michigan Medical Center, Ann Arbor). *J. Nucl. Med.;* **19**: No. 2, 149-153(Feb 1978).

Although adrenal imaging with 19-iodocholesterol provided much useful diagnostic information, spatial resolution was less than ideal. With the greater target-to-background ratios afforded by NP-59, differences between the right and left adrenal glands—in terms of position, configuration, and depth-related activity—can now be defined. Analysis of the scintigrams of 21 individuals with no evidence of adrenal disease has allowed us to characterize the normal degree of adrenal asymmetry. Appreciation of this asymmetry is necessary if the potential for greater diagnostic accuracy afforded by NP-59 is to be realized.

38181 Imaging the adrenal glands with radiolabeled inhibitors of enzymes: concise communication. Beierwaltes, W.H.; Wieland, D.M.; Mosley, S.T.; Swanson, D.P.; Sarkar, S.D.; Freitas, J.E.; Thrall, J.H.; Herwig, K.R. (Univ. of Michigan Medical Center, Ann Arbor). *J. Nucl. Med.;* **19**: No. 2, 200-203(Feb 1978).

Although radioiodinated cholesterols furnished the first noninvasive imaging of the adrenal glands, it would be desirable to decrease the time for imaging and decrease the radiation dose. The relative tissue distributions of two radiolabeled enzyme inhibitors [^3H] metyrapol and 1-125-SKF-12185 were studied in dogs and man. Their percentage uptakes and target-to-nontarget ratios were similar. The adrenals of three dogs were imaged sharply at 2 hr after injection with 4-6 mCi of I-131-SKF-12185, confirmed by subsequent imaging with 1 mCi of I-131-6-beta-19-nor cholesterol at 5 days after injection. The use of 1 mCi of I-123-SKF will pemit imaging of the adrenals in 1-2 hr and will decrease the radiation dose in the human to 0.76 rads to the adrenal, 0.18 rads to the ovaries and 1.7 rads to the liver.

38182 Antigenicity of the major polypeptides of hepatitis B surface antigen (HBsAg). Shih, J.W.; Tan, P.L.; Gerin, J.L. (Rockville Lab., MD). *J. Immunol.;* **120**: No. 2, 520-525(Feb 1978).

The major polypeptides (P-1, P-2, and P-6) of HBsAg were isolated from purified preparations of 22-nm HBsAg particles, iodinated, and analyzed by double-antibody radioimmunoprecipitation assays for the presence of hepatitis B virus (HBV)-specific antigens. Each polypeptide fraction contained both group (a) and subtype (d) specific determinants in common by virtue of their immunoreaction with antiserum to native HBsAg and antisera to the other structural polypeptides. The antigenic and structural similarities of the HBsAg polypeptides establish that they are not each unique gene products of the HBV genome.

38183 Adrenal imaging agents: rationale, synthesis, formulation, and metabolism. Beierwaltes, W.H.; Wieland, D.M.; Yu, T.; Swanson, D.P.; Mosley, S.T. (Univ. of Michigan Medical Center, Ann Arbor). *Semin. Nucl. Med.;* **8**: No. 1, 5-21(Jan 1978).

In this introductory paper on radionuclide adrenal imaging, the rationale, synthesis, formulation, and metabolism of two clinically well-established and one promising adrenocortical imaging agents are reviewed. Their present clinical utility is reviewed in a separate presentation in this issue. Progress to date in developing a positive imaging agent of the adrenal medulla and tumors of chromaffin tissue will be given brief consideration because there is, as yet, no clinically successful radiolabeled adrenal medulla imaging agent.

38184 Postadrenalectomy pituitary adenoma (Nelson's syndrome) in childhood: clinical and roentgenologic detection. Young, L.W.; Lim, G.H.K.; Forbes, G.B.; Bryson, M.F. (Univ. of Rochester, NY). *Am. J. Roentgenol., Radium Ther. Nucl. Med.;* **126**: No. 3, 550-559(Mar 1976).

From 17. annual meeting of the Society for Pediatric Radiology; San Francisco, CA, USA (22 Sep 1974).

Following total adrenalectomy in Cushing's syndrome associated with adrenal hyperplasia, but not with adrenal adenoma or malignancy, elements of the pituitary may be stimulated to grow rapidly and even aggressively. There is strong evidence to support the idea that there is pre-existing tumor in many, if not all, of these cases. In some, the tumor may be too small to deform the sella turcica. After adrenalectomy, these patients should be observed carefully and frequently for hyperpigmentation, visual field defects, and sella turcica enlargement.

MICROBIOLOGY

REFER ALSO TO CITATION(S) 37045, 38134, 38148, 38260, 38292

38185 FBJ osteosarcoma virus in tissue culture. III. Isolation and characterization of non-virus-producing FBJ-transformed cells. Levy, J.A. (Univ. of California, San Francisco); Kazan, P.L.; Reilly, C.A. Jr.; Finkel, M.P. *J. Virol.;* **26**: No. 1, 11-15(Apr 1978).

Hamster and rat cell lines have been established that have been transformed by FBJ murine sarcoma virus (FBJ-MuSV) but that do not produce virus. The hamster cell line originated from an osteosarcoma that appeared in a hamster inoculated at birth with an extract of a CF No. 1 mouse FBJ-osteosarcoma. The rat cell line was obtained by transferring the FBJ-MuSV genome to normal rat kidney cells in the absence of the FBJ type C virus (FBJ-MuLV), which, usually in high concentration, accompanies the FBJ-MuSV. Both transformed hamster and rat cell lines contain the FBJ-MuSV genome, which can be rescued by ecotropic and xenotropic murine type C viruses. This rescued genome produces characteristic FBJ-MuSV foci in tissue culture and, in appropriate animal hosts, induces osteosarcomas typical of those induced by FBJ-MuSV. FBJ-MuSV was isolated originally from a parosteal osteosarcoma that occurred naturally in a mouse. Since there was no previous history of passage of the agent through any other animal species, these non-virus-producing hamster and rat cells transformed by FBJ-MuSV should be very helpful in molecular studies examining the origin of spontaneous sarcoma genomes in mice.

38186 Late effect of bacteriophage T4D on the permeability barrier of Escherichia coli. Thompson, S.; Wiberg, J.S. (Univ. of Rochester, NY). *J. Virol.;* **25**: No. 2, 491-499(Feb 1978).

Cold centrifugation of lysiss-inhibited Escherichia coli B infected with wildtype T4D results in extensive lysis beginning around 20 min after infection at 37°C. Infection with an e mutant, which fails to make lysozyme, prevent lysis, but does not prevent a marked loss of K^+ and Mg^{2+}. The t gene product, thought to disrupt the cytoplasmic membrane in natural lysis, is not required for this handling-induced cation loss or lysis. Three lines of evidence argue that late protein synthesis is required to develop this potential for cation loss; the potential does not develop in infections by: (1) mutants defective in DNA synthesis, (2) mutants defective in gene 55, and (3) wild-type T4 when chloramphenicol is added at 6 min after infection. All late mutants examined, which are blocked in the major pathways of morphogenesis, do not prevent development of the potential. The evidence argues for a new, late effect of T4 infection on the cytoplasmic membrane.

38187 Isolation of a Bacillus subtilis 168 derivative sensitive to defective bacteriophage PBSX. Yasbin, R.E.; Ledbetter, M. (Brookhaven National Lab., Upton, NY). *J. Virol.;* **25**: No. 2, 703-704(Feb 1978).

A derivative of Bacillus subtilis strain 168 sensitive to defective bacteriophages PBSX and PBSZ has been isolated. This particular strain, RUB824, carries the genetic information for defective bacteriophage PBSX.

38188 Composition dynamic of mixed yeast culture at one and two substrate limitation. Furyaeva, A.V.; Pechurkin, N.S. (Inst. of Physics, Krasnoyarsk, USSR). *Izv. Sib. Otd. Akad. Nauk SSSR, Ser. Biol. Nauk;* No. 15, 120-125(Dec 1977). (In Russian).

Some laws of microbial association formation in continuous culture and ways of management of its composition are considered on the example of simultaneous growth of some yeast species. It is shown that the change of ratio of limiting components in feeding medium (sugars) leads to the change of composition of microbic association and to full elimination of some species. The possibility of using the growth kinetic characteristics of microorganisms as a means to find the ranges for a stable co-existence of species in mixed culture of necessary composition is studied.

38189 Midcycle doubling of uptake rates of adenine and serine in Saccharomyces cerevisiae. Kubitschek, H.E.; Edvenson, R.W. (Argonne National Lab., IL). *Biophys. J.;* **20**: No. 1, 15-22(Oct 1977).

Rates of uptake of serine and of adenine were measured as a function of cell size, and therefore age, in asynchronous, exponential phase cultures of diploid Saccharomyces cerevisiae strain Y55. In both cases, uptake rates were constant during the initial third of the cell cycle and doubled during the S period in the middle part of the cycle to a constant value during the final third. Cell size and age at mid-step doubling were indistinguishable for serine and adenine uptake, and occurred during the period of DNA synthesis. The results extend an earlier hypothesis of constancy of cell growth rates (mass accumulation rates) and rates of uptake of all or almost all compounds into cells in exponential phase growth to one of piecewise constancy, with an abrupt doubling of growth and uptake rates during DNA synthesis.

38190 Pathways of assimilation of $[^{13}N]N_2$ and $^{13}NH_4^+$ by cyanobacteria with and without heterocysts. Meeks, J.C.; Wolk, C.P.; Lockau, W.; Schilling, N.; Shaffer, P.W.; Chien, W.S. (Michigan State Univ., East Lansing). *J. Bacteriol.;* **134**: No. 1, 125-130(Sep 1977).

The principal initial product of metabolism of $[^{13}N]N_2$ and $^{13}NH_4^+$ by five diverse cyanobacteria is glutamine. Methionine sulfoximine inhibits formation of [^{13}N]glutamine except in the case of Gloeotnece sp., an organism with a thick sheath through which the inhibitor may not penetrate. Thus, glutamine synthetase appears to catalyze the initial step in the assimilation of N_2-derived or exogenous NH_4^+ by these organisms. [^{13}N]Glutamate is, in all cases, the second major product of assimilation of ^{13}N-labeled N_2 and NH_4^+. In all of the N_2-fixing cyanobacteria studied, the fraction of ^{13}N in glutamine declines and that in glutamate increases with increasing times of assimilation of $[^{13}N]N_2$ and $^{13}NH_4^+$, and (Gloeothece again excepted) methionine sulfoximine reduces incorporation of ^{13}N into glutamate as well as into glutamine. Glutamate synthase therefore appears to catalyze the formation of glutamate in a wide range of N_2-fixing cyanobacteria. However, the major fraction of [^{13}N]glutamate formed by Anacystis nidulans incubated with $^{13}NH_4^+$ may be formed by glutamic acid dehydrogenase. The formation of [^{13}N]alanine from $^{13}NH_4^+$ appears to be catalyzed principally either by alanine dehydrogenase (as in Cylindrospermum licheniforme) or by a transaminase (as in Anabaena variabilis).

38191 Observations on the distribution of microorganisms in desert soil. Vollmer, A.T.; Au, F.; Bamberg, S.A. *Great Basin Nat.;* **37**: No. 1, 81-86(31 Mar 1977).

Population estimates of fungi, bacteria, and actinomycetes in desert soil were determined with respect to soil depth and distance from shrubs. In general the highest numbers of microbes were found at the shrub base; the lowest numbers were found in the interspaces. While the total number of organisms usually declined in deeper soil, the relative importance of the actinomycetes increased. These population trends are attributed to substrate availability and utilization and interspecific interactions. As the soils became drier and warmer the total number of microorganisms decreased. Mold populations remained at about the same level during the study. While the numbers of both bacteria and actinomycetes declined, the relative importance of the actinomycetes increased.

PATHOLOGY

REFER ALSO TO CITATION(S) 38198

38192 (LA—7078-PR) **Serologic test systems development. Progress report, July 1, 1976—September 30, 1977.** Saunders, G.C.; Clinard, E.H.; Bartlett, M.L.; Petersen, P.M.; Sanders, W.M.; Payne, R.J.; Martinez, E. (Los Alamos Scientific Lab., N.Mex. (USA)). Jan 1978. Contract W-7405-ENG-36. 40p. Dep. NTIS, PC A03/MF A01.

Work has continued on the development and application of the Enzyme-Labeled Antibody (ELA) test to the USDA needs. Results on trichinosis, brucellosis, and staphylococcal enterotoxin A detection are very encouraging. A field test for trichinosis detection is being worked out in cooperation with Food Safety and Quality Service personnel. Work is in progress with the Technicon Instrument Corporation to develop a modification of their equipment to automatically process samples by the ELA procedure. An automated ELA readout instrument for 96-well trays has been completed and is being checked out.

PHYSIOLOGICAL SYSTEMS

REFER ALSO TO CITATION(S) 38134, 38135, 38140, 38182

38193 Analytical techniques for cell fractions. XXI. Two-dimensional analysis of serum and tissue proteins: multiple isoelectric focusing. Anderson, N.G.; Anderson, N.L. (Argonne National Lab., IL). *Plant Soil;* **85**: No. 2, 331-340(Apr 1978).

Two-dimensional electrophoresis, using isoelectric focusing in one dimension and electrophoresis in sodium dodecyl sulfate in the second, yields the highest resolution separation of proteins and protein subunits thus far obtained. For general research use, for genetic screening, and for clinical studies, it is important to be able to make these analyses easily, relatively rapidly, and reproducibly. This paper describes a device and methods for casting up to 20 isoelectric focusing gels in parallel, for running them in the same apparatus, and for recovering them in preparation for the second-dimension separations.

38194 Analytical techniques for cell fractions. XXII. Two-dimensional analysis of serum and tissue proteins: multiple gradient-slab gel electrophoresis. Anderson, N.L.; Anderson, N.G. (Argonne National Lab., IL). *Plant Soil;* **85**: No. 2, 341-354(Apr 1978).

Two-dimensional electrophoresis of proteins and protein subunits, employing isoelectric focusing in the first dimension and electrophoresis in the presence of sodium dodecyl sulfate in the second, yields the highest resolutions currently available. In this paper separations in the second dimension are considered (the so called DALT system). Methods for multiple-parallel casting of gra-

dient gels in slab gel holders are described. The problem of electrical isolation of the ends of the slabs together with continuous cooling of both surfaces of the slab gel holder along their entire length has been achieved by running the gels in a horizontal direction in a three-compartment tank with the holders inserted in insulating septa. In the system described, 10 slabs are run simultaneously. This, however, is not the upper limit of the number of slabs which can be conveniently run in parallel.

38195 Timing of gestation in rats by fetal and maternal weights. Knox, W.E.; Lister-Rosenoer, L.M. (Harvard Medical School, Boston). *Growth;* **42**: No. 1, 43-53(Mar 1978).

Weights of embryonic and fetal rats increase with gestational age from Day 13 to 20 in a strictly logarithmic manner and then slow. Data for other rat strains published as long ago as 1915 show substantially the same growth curves and the same weights as the inbred Kx strain studied. During this late gestational period fetal weights doubled every 1.22 days. An earlier period of somewhat faster growth can be inferred. These growth rates are virtually the same as the maximum rates at which rat neoplasms can grow. A regression equation was constructed from which the ages of rat embryos can be predicted from their weights within confidence limits of +-0.24 days. A similar logarithmic increase of added weight in the pregnant dam was recognized by which pregnancies could be conveniently diagnosed as early as Day 7. These two procedures facilitate the routine production of embryos of known age for experimental purposes.

38196 Suppression of the plaque-forming cell response by macrophages present in the normal rat spleen. Weiss, A.; Fitch, F.W. (Univ. of Chicago). *J. Immunol.;* **120**: No. 2, 357-359(Feb 1978).

Depletion of phagocytic and/or adherent cells from normal rat spleen cell preparations permitted the generation of PFC to SRBC in vitro. Suppressive activity was associated with the presence of macrophages in the normal rat spleen, since irradiated unfractionated or irradiated adherent cells suppressed the PFC response of macrophage-depleted cells. Whereas depletion of macrophages from normal rat spleen cells permitted the PFC response to SRBC to occur, comparable treatment of mouse spleen cells eliminated the PFC response. These results are discussed in relation to the requirement for macrophages in the generation of PFC with rat cells in vitro.

38197 Effects of short-term hypoxia on platelet counts of mice. McDonald, T.P.; Cottrell, M.; Clift, R. (Univ. of Tennessee Memorial Research Center, Knoxville). *Blood;* **51**: No. 1, 165-175(Jan 1978).

Recent studies have shown that long-term hypoxia causes decreased platelet counts in mice and short-term hypoxia increased platelet counts. In an attempt to explain the mechanism that increases platelet counts of mice after exposure to short-term hypoxia, we measured platelet counts, total circulating platelet counts (TCPC), total circulating platelet masses (TCPM), percentages of ^{35}S incorporation, and platelet sizes. Platelet counts, as well as TCPC and TCPM of mice, increased after 1 to 3 days of hypoxia but these values were decreased after 6 to 7 days of hypoxia. Although platelet counts were increased in hypoxic mice, the percentage ^{35}S incorporation into platelets and platelet sizes did not show a concurrent increase. After 6 days of hypoxia, average platelet diameters began to increase as platelet counts decreased. Splenic release did not account for the increase in platelet counts of mice after short-term hypoxia. It seems possible, therefore, that megakaryocytes shed platelets into the circulation in response to hypoxia. The platelets that enter the circulation in response to short-term hypoxia are smaller and incorporate less ^{35}S than platelets that are produced in response to acute thrombocytopenia.

38198 Amantadine effect on peripheral airways abnormalities in influenza: a study in 15 students with natural influenza A infection. Little, J.W.; Hall, W.J.; Douglas, R.G. Jr.; Hyde, R.W.; Speers, D.M. (Univ. of Rochester School of Medicine and Denistry, NY). *Ann. Intern. Med.;* **85**: 177-182(1976).

Amantadine HCl administration has resulted in accelerated resolution of influenza A illness. Prolonged abnormalities in pulmonary function have been described in uncomplicated influenza A. To study the effect of amantadine on these changes, we evaluated young adults with documented natural influenza A with clear chest examinations and x rays. Subjects received placebo or amantadine in random, double-blind fashion. Physiologic studies included maximal expiratory flow volume curves with air and helium-oxygen mixtures. Air flow rates were unchanged in all subjects throughout. Initially, both groups showed comparable decreases in mean helium-oxygen maximal expiratory flow rates. The amantadine group showed accelerated physiologic improvement: significant increase in helium-oxygen, flow rates occurred within 7 days ($P < 0.05$). The rate of improvement in the helium-oxygen flow rates in the placebo group was not statistically significant. These studies confirm peripheral airways dysfunction after uncomplicated influenza A and suggest that amantadine is associated with accelerated resolution of this dysfunction.

TRACER TECHNIQUES

38199 Relative importance of the bone marrow and spleen in the production and dissemination of B lymphocytes. Rosse, C.; Cole, S.B.; Appleton, C.; Press, O.W.; Clagett, J. (Univ. of Washington, Seattle). *Cell. Immunol.;* **37**: No. 1, 254-262(Apr 1978).

The relative importance of the bone marrow and spleen in the production of B lymphocytes was investigated in guinea pigs by the combined use of [^{3}H]TdR radioautography and fluorescent microscopy after the staining of B cells by FITC-F $(ab')_2$-goat-anti-guinea pig Ig. Large and small lymphoid cells possess sIg in the marrow and spleen but B cell turnover in the marrow exceeds that in the spleen. That newly generated bone marrow B cells are not derived from an extramyeloid bursa equivalent was demonstrated by the absence of [^{3}H]TdR labeled B cells in tibial marrow 72 hr after [^{3}H]TdR was administered systemically, while the circulation to the hind limbs was occluded. Pulse and chase studies with [^{3}H]TdR showed that large marrow B cells are derived from sIg-negative, proliferating precursors resident in the bone marrow and not from the enlargement of activated small B lymphocytes. The acquisition of [^{3}H]TdR by splenic B cells lagged behind that observed in the marrow. Three days after topical labeling of tibial and femoral bone marrow with [^{3}H]TdR, a substantial proportion of splenic B cells were replaced by cells that had seeded there from the labeled marrow. The studies unequivocally identify the bone marrow as the organ of primary importance in B cell generation, and indicate that in the guinea pig rapidly renewed B lymphocytes of the spleen are replaced by lymphocytes recently generated in bone marrow. The rate of replacement of B lymphocytes in the lymph node by cells newly generated in the bone marrow takes place at a slower tempo than in the spleen.

PUBLIC HEALTH

REFER ALSO TO CITATION(S) 37955, 38300

AGRICULTURE AND FOOD TECHNOLOGY

REFER ALSO TO CITATION(S) 36693, 36694, 37518, 37563, 37597

38200 Phosphorus fertilizer as a by-product of energy production from agricultural wastes. Siegel, R.S.; Rubin, J.; Hafez, A.A.R.; Stout, P.R. (Univ. of California, Davis). *J. Environ. Qual.;* **6**: No. 2, 116-120(1977).

A regional survey of sewage sludge composition was conducted by obtaining data for 30 constituents in >250 sewage sludge samples from approximately 150 treatment plants located in 6 states in the north-central region and 2 in the eastern region. Computation of the mean and median values indicated that N, P, and K levels were within a relatively narrow range, whereas these statistics demonstrated that Pb, Zn, Cu, Ni, and Cd concentrations were extremely variable. Median concentrations for anaerobically digested sewage sludges were as follows: N, 4.2; P, 3.0; K, 0.3% Pb, 540; Zn, 1,890; Cu, 1,000; Ni, 85; and Cd, 16 mg/kg, and for aerobically treated sludges: N, 4.8; P, 2.7; K, 0.4%; Pb, 300, Zn, 1,800; Cu, 970; Ni, 31; and Cd, 16 mg/kg. Based on population and sludge production estimates, <1% of the agricultural land would be required for application of sewage sludge at a rate of 100 kg available N per ha in most of the states considered. The heterogeneous nature of sewage sludges produced by different cities and the presence of potentially harmful trace metals necessitates a knowledge of the chemical composition of each individual sewage sludge prior to land application.

BIOMEDICAL SCIENCES, APPLIED STUDIES

RADIATION EFFECTS ON BIOCHEMICALS

IN VITRO

REFER ALSO TO CITATION(S) 37800

38201 (BNL—24006) **Mechanism of action of the photoreactivating enzyme from E. coli: recent results.** Sutherland, J.C. (Brookhaven National Lab., Upton, N.Y. (USA)). 1978. Contract

EY-76-C-02-0016. 4p. (CONF-780226—6). Dep. NTIS, PC A02/MF A01.

From Symposium on DNA repair mechanisms; Keystone, CO, USA (19 Feb 1978).

Purified photoreactivating enzyme (PRE) from E. coli has an absorption maximum at 257 nm, but no well defined absorption band for lambda > 300 nm, the wavelength region which is required for photorectivation. When PRE is mixed with ultraviolet irradiated DNA (uv DNA), there is an increase in absorption for lambda > 300 nm. Absorbance changes are not observed if PRE is mixed with unirradiated DNA nor is the increase for lambda > 300 nm due to an increase in light scattering. Thus, the long sought "chromophore" appears to be a molecular complex which exists only when E. coli PRE interacts with dimer-containing DNA and leads us to ask what are the moieties of the dimer and the PRE which interact to produce the new absorption band. A preliminary step in identifying the interacting moieties of the dimer is determining whether the PRE approaches the dimer from the major or the minor groove of the DNA. If the PRE approaches from the major groove it can interact with the cyclobutyl ring while if it approaches from the minor groove, it might interact with the two carbonyl groups at the 2 positions of the pyrimidine ring which are common features of all photoreactable dimers. Recent data show that the basic peptide antibiotic netrospin, which is known to bind in the minor groove, inhibits binding of the PRE to uvDNA.

38202 Electron spin-resonance of x-irradiated nucleic acid base pairs, 1-methyl cytosine:5-fluorouracil at 300 K. Close, D.M.; Farley, R.A.; Bernhard, W.A. (Univ. of Rochester, NY). *Radiat. Res.;* 73: No. 2, 212-220(Feb 1978).

Three free radicals have been detected in single crystals of a molecular complex between 1-methylcytosine (1 MeC) and 5-fluorouracil (5 FU) x-irradiated and observed by ESR at 77 K. One of these (Radical I), formed by H abstraction from N(1) of 5 FU, disappears when the crystal is warmed to 220 K. The other two radicals are stable at room temperature. Radical II is formed by H addition to C(6) of 5 FU. Radical III has been tentatively assigned to a radical formed by H addition to the oxygen on C(4) of 5 FU. The structural analysis of these two stable room-temperature radicals and the resulting implication that free radical damage may be transferred from 1 MeC to 5 FU are discussed.

RADIATION EFFECTS ON CELLS

38203 (ANL—77-55, pp 173-188) **Mammalian cell biology.** 1976.

In Division of Biological and Medical Research annual report, 1976.

Progress is reported on studies of the molecular biology and functional changes in cultured mammalian cells following exposure to x radiation, uv radiation, fission neutrons, or various chemical environmental pollutants alone or in combinations. Emphasis was placed on the separate and combined effects of polycyclic aromatic hydrocarbons released during combustion of fossil fuels and ionizing and nonionizing radiations. Sun lamps, which emit a continuous spectrum of near ultraviolet light of 290 nm to 315 nm were used for studies of predictive cell killing due to sunlight. Results showed that exposure to uv light (254 nm) may not be adequate to predict effects produced by sunlight. Data are included from studies on single-strand breaks and repair in DNA of cultured hamster cells exposed to uv or nearultraviolet light. The possible interactions of the polycyclic aromatic hydrocarbon 7,12-dimethylbenz(a)-anthracene (DmBA) alone or combined with exposure to x radiation, uv radiation (254 nm) or near ultraviolet simulating sunlight were compared for effects on cell survival.

EXTERNAL SOURCE

38204 Kinetics of thymine dimer excision in ultraviolet-irradiated human cells. Ehmann, U.K.; Cook, K.H.; Friedberg, E.C. (Stanford Univ., CA). *Biophys. J.;* 22: No. 2, 249-264(May 1978).

We have investigated the kinetics of the loss of thymine dimers from the acid-insoluble fraction of several ultraviolet (uv)-irradiated cultured human cell lines. Our results show that uv fluences between 10 and 40 J/m^2 produce an average of 21 to 85 x 10^5 thymine dimers per cell and an eventual maximal loss per cell of 12 to 20 x 10^5 thymine dimers. The time for half-maximal loss of dimers ranged from 12 to 22 h after uv irradiation. In contrast, the time for half-maximal repair synthesis of DNA measured by autoradiography was 4.5 h. This figure agrees well with reported half-maximal repair synthesis times, which range from 0.5 to 3.6 h based on our analysis. The discrepancy in the kinetics of the loss of thymine dimers from DNA and repair synthesis is discussed in terms of possible molecular mechanisms of thymine dimer excision in vivo and in terms of possible experimental artifacts.

38205 Excision repair of ultraviolet damage in mammalian cells: evidence for two steps in the excision of pyrimidine dimers. Williams, J.I.; Cleaver, J.E. (Univ. of California, San Francisco). *Biophys. J.;* 22: No. 2, 265-279(May 1978).

The incidence of pyrimidine dimer formation and the kinetics of DNA repair in African green monkey kidney CV-1 cells after ultraviolet (uv) irradiation were studied by measuring survival, T4 endonuclease V-sensitive sites, the fraction of pyrimidine dimers in acid-insoluble DNA as determined by thin layer chromatography (TLC), and repair replication. CV-1 cells exhibit a survival curve with extrapolation number n = 7.8 and D_0 = 2.5 J/m^2. Pyrimidine dimers were lost from acid-insoluble DNA more slowly than endonuclease-sensitive sites were lost from or new bases were incorporated into high molecular weight DNA during the course of repair. Growth of CV-1 cultures in [^{3}H]thymidine or x irradiation (2 or 10 krads) 24 h before uv irradiation had no effect on repair replication induced by 25 J/m^2 of uv. These results suggest that pyrimidine dimer excision measurements by TLC are probably unaffected by radiation from high levels of incorporated radionuclides. The endonuclease-sensitive site and TLC measurements can be reconciled by the assumption that pyrimidine dimers are excised from high molecular weight DNA in acid-insoluble oligonucleotides that are slowly degraded to acid-soluble fragments.

38206 Ultraviolet light and x-ray damage interaction in Chinese hamster cells. Han, A.; Elkind, M.M. (Argonne National Lab., IL). *Radiat. Res.;* 74: No. 1, 88-100(Apr 1978).

The age-response variations in survival of V79 Chinese hamster cells following the combined administration of a fixed dose of x rays and a dose of uv radiation show enhanced cell killing at all cell ages. The greatest interaction is observed in the middle of the DNA synthetic phase where the shoulders on both the x-ray and uv survival curves are large. In the middle of the DNA synthetic phase, a dose of uv radiation reduces the ability of surviving cells to accumulate sublethal damage due to x rays and vice versa; the amount of shoulder removed, however, is always greater when uv precedes x rays. Thus, at equal survival levels, x-ray damage is completely additive to uv-induced sublethal damage, while uv damage is only in part additive to x-ray-induced sublethal damage. If an interval for repair is introduced between these two types of radiation, the loss of interaction following a dose of x rays is more rapid than following a dose of uv as judged by the rate of reappearance of the shoulder on the respective survival curves. The data indicate that the damage due to nonionizing and ionizing radiation in Chinese hamster cells interacts and is additive; we suggest that this is because of overlapping action at the level of nuclear DNA.

38207 Radiation biophysical studies with mammalian cells and a modulated carbon ion beam. Chapman, J.D.; Blakely, E.A.; Smith, K.C.; Urtasun, R.C.; Lyman, J.T.; Tobias, C.A. (Univ. of California, Berkeley). *Radiat. Res.;* 74: No. 1, 101-111(Apr 1978).

Chinese hamster (V-79) and human kidney (T-1) cells were irradiated in stirred suspensions placed at various positions in the plateau and extended Bragg peak of a 400-MeV/amu carbon ion beam. The range of the ions was modulated by a lead (translational) ridge filter and a brass (spiral) ridge filter designed to produce extended peaks of approximately 4 and 10 cm, respectively. Stationary-phase and G_1-phase populations of Chinese hamster cells were found to have different absolute radiosensitivities which, in turn, were different from that of asynchronous human kidney cells. The increase in relative biological effectiveness (RBE) observed as carbon ions were slowed down and stopped in water was similar for the three cell populations at doses greater than 400 rad. At lower doses the RBE was greater for the hamster cell populations than for the human kidney cells. The gain in RBE (at the 50% survival level) between the plateaus and the middle region of the extended peaks was approximately 2.0 and 1.7 for the 4- and 10-cm extended peaks, respectively. Oxygen enhancement ratios (OER) were determined at the 10% survival levels with stationary-phase populations of hamster cells. Values of 2.8, 2.65, and 1.65 were obtained for the OER of 220-kV x rays, plateau carbon, and the middle region of the 4-cm carbon peak, respectively. Across the 10-cm carbon peak the OER was found to vary between values of 2.4 to 1.55 from the proximal to distal positions.

38208 DNA replication in x-irradiated Chinese hamster cells made permeable to deoxyribonucleoside triphosphates. Olson, A.C.; Billen, D. (Oak Ridge National Lab., TN). *Radiat. Res.;* 74: No. 1, 199-204(Apr 1978).

Chinese hamster ovary cells that were x-irradiated (500 to 2000 rad) and permeabilized to deoxyribonucleoside triphosphates by exposure to 1% Tween 80 in 0.25 M sucrose incorporated [^{3}H]dTMP to the same extent as did unirradiated control cells.If the cells were returned to growth conditions ("holding" experiments) for 30 to 120 min after irradiation, but before permeabilization, subsequent [^{3}H]dTMP incorporation was depressed by about 20%. By 3 hr postirradiation, such cells had fully recovered. This 20%

depression of DNA synthesis is too much to be accounted for by a failure of irradiated cells to enter S-phase. Furthermore, autoradiography showed that the same fraction of the cells was actively synthesizing DNA whether or not they had been irradiated and/or held. Our data support the conclusion that low doses of x rays inhibit initiation of DNA synthesis in individual replicons.

38209 Chromosomal aberrations in swine leukocytes after in vivo or in vitro exposure to fission neutrons. Mailhes, J.B.; McFee, A.F.; Poston, J.W. (Comparative Animal Research Lab., Oak Ridge, TN). *Radiat. Res.;* **71**: No. 3, 561-570(Sep 1977).

Chromosomal aberrations were evaluated in swine leukocytes after their in vivo or in vitro exposure to various levels of fission neutrons. The best statistical fit for the dose-response data from both exposure methods was to a linear model. Aberration indices were significantly higher (P less than 0.01) following in vitro exposure of an animal's blood than in samples taken 30 min after irradiation of the animal. Dose attenuation and differences in the relative contributions of the neutron and gamma components reaching the target cells produced a difference in the biologically effective dose received by the leukocytes under the two exposure conditions. When the data were adjusted for these factors, the level of acentric fragments was comparable between exposure methods, but rings plus dicentrics were still more abundant after in vitro irradiation. Mathematical equations were constructed to predict in vivo damage from the in vitro aberration coefficient.

38210 Repair of potentially lethal damage in Chinese hamster cells afer x and α irradiation. Raju, M.R.; Frank, J.P.; Bain, R.; Trujillo, T.T.; Tobey, R.A. (Los Alamos Scientific Lab., NM). *Radiat. Res.;* **71**: No. 3, 614-621(Sep 1977).

Recovery from potentially lethal damage (PLD) of cultured Chinese hamster cells (line CHO) after exposure to x rays and to α particles was investigated using both exponentially growing and plateau-phase cells (nutritionally induced stationary phase). The results indicated that there was no recovery from PLD after exposure to α particles from plutonium. Experiments were also conducted to determine if recovery phenomena were dependent on cell concentration. Recovery from PLD after x-ray exposure was not dependent on cell concentration. Cell-to-cell contact also does not seem to be an important factor in PLD recovery. The recovery curve shape after exposure to x rays, both for exponentially growing and plateau-phase CHO cells, remained identical; however, the magnitude of repair by plateau-phase cells was higher than by exponentially growing cells, indicating that cells in G_1 may be primarily involved in PLD recovery.

INTERNAL SOURCE

REFER ALSO TO CITATION(S) 38234

RADIATION EFFECTS ON MICROORGANISMS

REFER ALSO TO CITATION(S) 38165

BASIC STUDIES

38211 Applications of models for cell survival: the fixation time picture. Garrett, W.R.; Payne, M.G. (Oak Ridge National Lab., TN). *Radiat. Res.;* **73**: No. 2, 201-211(Feb 1978).

Some simple applications of cell survival models for low-LET radiation are examined. The fixation time picture of mediating lethality in previously formulated two- and three-state survival models is utilized in the analysis of experiments involving liquid holding recovery, repair inhibitors, and the effects of growth media on cell survival.

38212 Identification by irradiation, in vitro, of two components of erythroprotein action. Barcos, M. (Univ. of Chicago). *Radiat. Res.;* **73**: No. 2, 303-314(Feb 1978).

The effect of ionizing radiation on the response of normal cultured rat marrow cells to erythropoietin yielded two-component inactivation curves for induced iron uptake and hemoglobin synthesis. The radioresistant component of the induced hemoglobin response (1) was detected earlier, at 6 to 20 hr after irradiation, (2) had a $DO_0 >$ or = to 900 R, (3) gave a nonlinear erythropoietin dose—response plot at 600 R, (4) disappeared when marrow from erythremic rats was used, and (5) showed maximal inactivation by 500 R when irradiation preceded hormone addition by 1.5 to 2.5 hr. The radiosensitive component (1) was observed without any contribution from the radioresistant component when the time of assay of normal marrow was postponed from 6 to 20 hr to 20 to 44 hr of culture, (2) had a $D_0 = 63$ R, (3) gave linear erythropoietin dose—response curves at 15 to 60 R, and (4) showed enhanced inhibition by 60 R if irradiation either preceded or followed hormone addition by 3 hr or more.

38213 Additive sensitization of bacterial spores by oxygen and p-nitroacetophenone. Ewing, D. (Univ. of Texas, Austin). *Radiat. Res.;* **73**: No. 1, 121-136(Jan 1978).

Ib the bacterial spore, the sensitizing effects of both oxygen and p-nitroacetophenone (PNAP) can be separated into components. Each sensitizer has a component of damage which involves reactions of hydroxyl radicals (.OH), although the origins of these components may be different. Tests which use different concentrations of PNAP and O_2 simultaneously have been run to seek interactions or additives in their effects on lethal radiation sensitivity. The results show that the effects of the PNAP "non-.OH" component are additive to those of both O_2 "non-.OH" components; however, the patterns of this additivity suggest that the chemical processes through which PNAP acts are similar to those of the high-O_2 component (that is, the component which occurs at $[O_2] > 5 \times 10^{-5}$ M) but are different from those of the low-O_2 component. There is also indirect evidence that the sensitizing reactions of the high-O_2 component may replace those reactions of hydroxyl radicals which occur at lower $[O_2]$. If O_2 does replace .OH in some damaging chemical reactions, the unexpected disappearance of the .OH component as the $[O_2]$ is raised would be understandable.

38214 X-ray and proton-induced ultrastructural changes in dividing Chlamydomonas reinhardi. Gruber, H.E. (Oregon State Univ., Corvallis). *Radiat. Res.;* **73**: No. 1, 137-159(Jan 1978).

Early in the dark period of a 12-hr light, 12-hr dark synchronization regime cells of Chlamydomonas reinhardi are either in division or preparing for it, and are more sensitive to x and proton irradiation as expressed in terms of mortality and mechanisms of death exhibited by lethally injured cells. Irradiated and control cells were fixed for electron microscopic examination at intervals up to 5 days postexposure. X irradiation with 9000 R produced 69% mortality in 137c wild type cells and 71% mortality in the acetate-requiring strain ac-31. Ultrastructural responses observed in x-irradiated cells included nuclei with nonnuclear condensations and swollen nuclear envelopes, nuclear envelope rupture in cells in an advanced state of disorganization, multinucleate cells and changes in chloroplasts and mitochondria. Irradiation of dividing 137c cells with 1.5-MeV protons possessing a dE/dx of 200 MeV cm^2/g produces 89% mortality following 9 krad and 98.3% following 18 krad. Proton-induced changes resembled those observed following x irradiation. Multiple nuclei per cell and variations in staining intensity of entire cells or parts of cells are documented. Two features absent in control cells were of special interest following both types of irradiation: (1) Cells were observed which remained joined in configurations closely resembling division profiles or division conformation. (2) Chromosomes and spindle fibers were present at a time not characteristic of the normal cell cycle.

FOOD PRESERVATION

REFER ALSO TO CITATION(S) 38144

VACCINE PREPARATION AND OTHER APPLICATIONS

REFER ALSO TO CITATION(S) 37023

RADIATION EFFECTS ON PLANTS

BASIC STUDIES

38215 Monoenergetic neutron induced effects on cell progression in broad bean roots. Geard, C.R.; Povlas, S.; Mrino, S. (Columbia Univ., New York). *Radiat. Res.;* **73**: No. 1, 160-167(Jan 1978).

Following irradiation with monoenergetic neutrons of 15.1, 1.91, 0.43, and 0.23 MeV, cells of broad bean roots are delayed in progression through the cell cycle. There is an exponential relation between cells progressing ("surviving") into mitosis and dose over a range of time periods. Relative biological effectiveness (RBE) increases with decreasing neutron energy and the two lowest energies are similar in effect. The RBE-neutron energy dependence for this largely transitory delay phenomenon in general approximates that found for permanent radiobiological endpoints, possibly indicating that this effect depends on the square of the energy absorbed in sites of nuclear size or smaller.

RADIATION EFFECTS ON ANIMALS

38216 Biochemical and morphological changes in the epithelial cells of the small intestine after irradiation. Becciolini, A.; Arganini, L.; Tedde, G.; Vannelli, G.; Cariaggi, P. (Univ., Florence). *Int. J. Radiat. Oncol., Biol. Phys.;* **1**: No. No. 9-10, 915-925(1976).

Rats have been sacrificed after abdominal irradiation with sublethal doses at very close intervals. Observation at light and

electron microscope have been carried out on the small intestine of these animals in order to try to explain the simultaneous modifications of leucineaminopeptidase (LAP) activity. In connection with the increase of LAP activity no modifications have been evidenced, at the light microscope, in the differentiated cells of the villus where the membrane digestion process takes place. In the crypt-villus junction we observe at the electron microscope a remarkable increase in the number of ribosomes since the early intervals. Also during the return phase to normal activities the cells of the crypt and of the crypt-villus junction show a temporaneous increase in the amount of ribosomes. Shortly afterwards we observe an increase of LAP activity.

MAN

REFER ALSO TO CITATION(S) 38170

38217 (ORAU/IEA(O)—77-25) **Recombinant DNA in Cambridge: lessons for nuclear energy.** Federow, H. (Institute for Energy Analysis, Oak Ridge, Tenn. (USA)). Sep 1977. Contract EY-76-C-05-0033. 24p. Dep. NTIS, PC A02/MF A01.

The 1976 experience of Cambridge, Massachusetts, in settling the recombinant DNA research issue is unique in recent history as the first instance of essentially lay panels judging the conduct of scientific research. Furthermore, because the panel was composed of citizens who would be affected by the research, the experience suggests a model for conflict resolution in other areas of public controversy. With one of these, nuclear energy, the controversy has two important points in common: although the primary burden of any accident would be borne by the local community, benefits of the DNA research or reactor operation accrue to a much broader range of people; and in both issues there is a need to resolve the question, "How safe is safe enough." It is therefore proposed that a panel similar to the Cambridge one could be established to deal with the controversy surrounding a proposed nuclear plant. In any community where there was such controversy, a panel could be convened to assess whether the plant was acceptable to that community. Such a panel would be composed of members of the community who were not affected directly by the plant. It would also have to have a restricted range of inquiry, oriented toward the specifics of the proposed plant. Such a plant review panel, under properly designed procedures, could change the licensing process to one concerned solely with safety and provide an appropriate forum for issues concerning the acceptability of nuclear power.

38218 Investigation of pion-treated human skin nodules for therapeutic gain. Kligerman, M.M.; Sala, J.M.; Wilson, S.; Yuhas, J.M. (Univ. of New Mexico, Los Alamos). *Int. J. Radiat. Oncol., Biol. Phys.;* **4**: No. 3/4, 263-265(1978).

A patient with multiple metastatic tumor nodules in the skin, from a primary breast carcinoma, was treated with graded doses of pions and x rays to establish skin tolerance. She was followed up for 346 days, permitting observation of time to regrowth of the tumor nodules. All 16 of these had disappeared after treatment, without significant correlation with type of radiation or dose, or with nodule size. However, time to regrowth depended both on the type and the dose of radiation. Earlier, relative biological effectiveness (RBE), was established at 1.42 for acute skin injury. Using this RBE to normalize doses of pions and x rays causing equivalent acute skin injury, and plotting those doses vs time to regrowth of tumor nodules, yielded a therapeutic gain (37.5%) in favor of pions. No late skin or subcutaneous tissue changes were seen, and no qualitative difference between pions and x rays in late skin effects was observed.

VERTEBRATES

REFER ALSO TO CITATION(S) 37953

38219 (ANL—77-55) **Division of Biological and Medical Research annual report, 1976.** Rosenthal, M.W. (ed.). (Argonne National Lab., Ill. (USA)). 1976. Contract W-31-109-ENG-38. 254p. Dep. NTIS, PC A12/MF A01.

Separate abstracts were prepared for 14 sections of this report. Abstracts are included of publications during the period.

38220 (ANL—77-55, pp 5-30) **Neutron and gamma-ray toxicity studies.** 1976.

In Division of Biological and Medical Research annual report, 1976.

A kinetic model for radiation-induced life shortening in mice, due to late effects produced by low doses of ionizing radiation, has been developed. The model is based on the concept that an increase in the age-specific force of mortality after exposure to radiation is a consequence of some form or forms of irreversible injury induced by the radiation. Life-shortening responses generated using the model have been shown to be consistent with available data for mice after single or fractionated doses of low- or high-LET radiation. Dose-RBE curves based on life-shortening responses have also been generated. The use of two types of radiation, with quantitative differences in their biological effects, is an integral component of the program: gamma radiation from ^{60}Co sources, and fission neutron radiation from the JANUS reactor. One of the most important differences is the relative lack of dose-rate effects with the latter. Single exposures of neutrons at low doses, down to the lowest dose at which lethal effects or selected physiological changes can be reasonably expected to be observed with a finite number of animals were used. A limited number of experiments with fractionated doses were also carried out to assess the validity of the assumption of dose-rate independence. The problem of gamma radiation emphasized dose protraction and fractionation. There is an extensive body of information available concerning dose-rate effects on life shortening, based largely on duration-of-life exposure. Considerably less is known about protraction and fractionation effects on tumorigenesis.

38221 (ANL—77-55, pp 31-43) **Radiation toxicity in dogs.** 1976.

In Division of Biological and Medical Research annual report, 1976.

Data are reported from a study of the detailed responses of of beagle dogs subjected to continuous (22 hr/day) irradiation from a ^{60}Co gamma-ray source. The effects of three major factors associated with the irradiation procedures explored were: the daily irradiation dose rate; the accumulated total exposure to radiation; and the influence of age at the time irradiation was initiated on the effects observed. The responses of young adult (about 400 days of age) beagles of both sexes, kept in the gamma-ray field until they die, were compared with those of similar dogs that had accumulated predetermined total exposures ranging from 600 to 4000 R. In addition, the developing beagle fetus was irradiated continuously throughout its gestation period, and this work is being extended to include the postnatal period.

38222 (ANL—77-55, pp 47-73) **Carcinogenesis.** 1976.

In Division of Biological and Medical Research annual report, 1976.

Progress is reported on studies at the molecular, biochemical, and immunological level of carcinogenesis induced in mice by viruses, radiation, or environmental chemicals alone or in combinations. Emphasis was placed on the identification and assessments of cocarcinogens and studies on their mechanisms of action. Data are included on mechanisms of carcinogenesis in the liver, thyroid, Harderian glands, skin, and lungs. The effects of the food additive butylated hydroxytoluene (BHT), phenobarbitol, DDT, uv irradiation, the herbicide 3-amino-1,2,4-triazole(AT), the pituitary hormone prolactin, topically applied 8-methoxypsoralen (8-MOP), and benzo(a) pyrene(BaP) on tumor induction or enhancement were studied.

38223 Rat skin tumor incidence following single and fractionated exposures to proton radiation. Burns, F.J.; Strickland, P.; Vanderlaan, M.; Albert, R.E. (New York Univ. Medical Center). *Radiat. Res.;* **74**: No. 1, 152-158(Apr 1978).

Experiments were conducted to establish the dose—response curve and degree of split-dose recovery for tumor induction and hair follicle survival in rat skin irradiated with protons. A proton beam from a cyclotron was modified to provide an approximately linear decrease in dose with depth in tissue to a maximum of about 1.3 mm. Six doses were given in the range from 75 to 750 rad. The tumor yield at 100 weeks after irradiation increased as $D^{2.8}$. Split doses consisted of an initial dose of 150 rad followed 24 hr later by graded doses in the range from 150 to 600 rad. Split doses produced a sparing effect on follicle killing and on the yield of tumors. The magnitude of the reduction in tumor yield was consistent with complete recovery. Comparisons with previous results indicated that protons were 2.0 to 2.4 times as effective as electrons for tumor induction and that the shapes of the dose—response curves were generally similar.

38224 Combined use of local irradiation and corynebacterium parvum in the treatment of the murine line 1 lung carcinoma. Ullrich, R.L.; Adams, L.M. (Oak Ridge National Lab., TN). *Radiat. Res.;* **73**: No. 2, 267-273(Feb 1978).

The effectiveness of Corynebacterium parvum in combination with local irradiation has been examined in the treatment of the murine line 1 lung carcinoma, a highly radioresistant, weakly immunogenic tumor that kills the host by means of metastatic spread. Sixteen-week-old, specific-pathogen-free female BABL/c mice were given 10^6 tumor cells im into the right thigh. Tumors were irradiated on Day 7 after transplant. Those receiving C. parvum treatment were given 0.1 mg either by the intralesional (il), ip, or iv route on Day 4 after transplant or by the il or ip route on Day 8. An additional group received C. parvum ip once a week for 4 weeks beginning on Day 8. The influence of the various treatments on local control and metastasis was assessed. To evaluate further the time course and incidence of metastases, cleared lungs were examined at 21, 28, and 35 days in groups given irradiation combined with C.

parvum on day 8. C. parvum was more effective in facilitating local control and inhibiting metastatic spread when given after radiation exposure rather than before.

38225 Single, stimulatable transport system in rat liver shared by certain amino acids following whole-body γ-irradiation. Flory, W.; Neuhaus, O.W. (Univ. of South Dakota School of Medicine, Vermillion). *Radiat. Res.;* **73**: No. 2, 351-359(Feb 1978).

Exposure of rats to whole-body γ irradiation stimulated the hepatic transport of α-aminoisobutyric acid, N-methyl α-aminoisobutyric acid, cycloleucine, L-methionine, and glycine by a common Na^+-dependent transport system. This was demonstrated using reciprocal inhibition transport studies involving liver slices from normal and irradiated rats. The five amino acids studied were mutually inhibitory of each others transport in both normal and irradiated animals. Although the hepatic accumulation of L-phenylalanine was not stimulated by γ irradiation, it effectively inhibited the stimulated transport AIB, methionine, cycloleucine, and glycine. In normal rats it inhibited the Na^+-dependent systems for AIB, cycloleucine, and L-methionine to different degrees.

38226 Hormonal control of amino acid transport in the liver of rats exposed to whole-body γ-irradiation. Kilberg, M.S.; Neuhaus, O.W. (Univ. of South Dakota School of Medicine, Vermillion). *Radiat. Res.;* **73**: No. 2, 360-372(Feb 1978).

Whole-body exposure of rats to γ rays led to a degeneration of tissue proteins and a concomitant elevation in blood amino acids. Simultaneously there was a stimulated uptake of amino acids by the liver and a state of gluconeogenesis and glycogenesis. It has now been established that these events were accompanied by increases in both blood glucagon and insulin levels. Growth hormone and corticosterone were not affected. Although both glucagon and insulin stimulate amino acid transport, the former was primarily responsible for the elevated transport in the liver following whole-body irradiation. The primary role of glucagon was demonstrated by the radiation-induced uptake of N-methyl α-aminoisobutyric acid, a model amino acid whose hepatic transport was previously shown to be affected by glucagon and not by insulin. Confirmatory evidence was obtained by showing that exogenous insulin actually inhibited the radiation-induced uptake of α-aminoisobutyric acid and N-methyl α-aminoisobutyric acid by the isolated perfused liver. Furthermore, the radiation syndrome was accompanied by elevated hepatic concentrations of cyclic AMP.

38227 X-ray-induced chromosome aberrations in mouse dictyate oocytes. II. Fractionation and dose rate effects. Brewen, J.G. (Oak Ridge National Lab., TN); Payne, H.S.; Adler, I.D. *Genetics;* **87**: No. 4, 699-708(Dec 1977).

Split-dose experiments were done on maturing dictyate oocytes to determine if the magnitude of the first dose influenced the "rejoining time" of radiation-induced chromosomal lesions. A total dose of 400 r was split into various combinations with varying fractionation intervals. The data derived from analyzing interchanges indicate that there is no difference in the rejoining time whether the first dose was 100, 200, or 300 r. It thus appears that the radiation dose in the ranges studied does not significantly alter the rate of repair of the chromosomal lesions. This conclusion is contrary to that which has been propounded to explain the nonlinear dose curves obtained for specific locus mutations. Chronic ^{60}Co γ-ray exposures were given to female mice over an 8-day period. The exposures were delivered during the period of peak sensitivity, i.e., 8 to 16 days prior to ovulation. The doses given were 117, 240, 348, and 483 r. The aberration yields observed were dramatically lower than for comparable doses of acute x rays even when the RBE of γ rays compared with x rays is taken into account. The large drop in yields at the low dose rates is interpreted as resulting from a large two-track component in the acute curve, and as being independent of effects on repair systems.

38228 Irradiation-induced erythroleukemia and myelogenous leukemia in the beagle dog: hematology and ultrastructure. Seed, T.M.; Tolle, D.V.; Fritz, T.E.; Devine, R.L.; Poole, C.M.; Norris, W.P. (Argonne National Lab., IL). *Blood;* **50**: No. 6, 1061-1079(Dec 1977).

A high incidence of leukemia in adult beagle dogs was induced by continuous whole-body exposure to low doses of ^{60}Co gamma irradiation. At 5, 10, and 17 R per 22-hr exposure day, 20 animals of 53 died of either myelogenous leukemia (15 of 20) or erythroleukemia (5 of 20); the latter occurred only at 5 R/day. Consistent preclinical changes occurred in the peripheral blood, including a partial recovery from an initial severe leukopenia, a prolonged accommodation-to-irradiation phase, and marked oscillations in platelet values in the preleukemic period. In the terminal condition the dogs were severely anemic, thrombocytopenic, and commonly leukopenic. Peripheral blood buffy-coat preparations contained circulating "blast" cells and juvenile forms. Abnormal erythrocyte and platelet morphology was consistently present. The bone marrow was altered most severely; other organs showed variable degrees of leukemic infiltration and proliferation and loss of normal tissue architecture. The marrow was hyperplastic with little or no fat remaining. Differential marrow cell counts showed increased numbers of immature cell forms. Myeloid:erythroid (M:E) ratios ranged from 2.6:1 to 61.5:1 in the granulocytic leukemias, and 0.2:1 to 1:1 in the erythroleukemias. Juvenile leukemic cells (both circulating and tissue forms) displayed a number of distinctive cytologic features, including asynchronous patterns of nuclear-cytoplasmic maturation, increased incidence of nuclear clefts, coalescence of cytoplasmic granules, and bizarre arrangements of endoplasmic reticulum. These experimentally induced canine leukemias have many hematologic and cytologic features in common with both spontaneous and radiation-induced leukemias of man. Thus, they may provide a useful model for the study of human leukemia.

38229 Status of T- and B-cell cooperation in radiation chimeras: evidence for a suppressor effect. Gengozian, N.; Urso, P. (Oak Ridge Associated Universities, TN). *Transplant. Proc.;* **8**: No. 4, 631-635(Dec 1976).

Absolute tolerance may not be in operation in the allogeneic bone marrow chimera, but rather a dynamic state involving interaction not only between the donor and host but also among the donor-lymphoid cells themselves may exist. Whether this observation made in one allogeneic chimera, $CD2F_1 \rightarrow C3BF_1$, will be true for other chimeras (different strain combinations, species) remains to be shown. Thus, the tempo, mode, and requirement for the generation of suppressor T cells are factors that may vary for any specific allogeneic bone marrow transplant. Finally, the manner and degree to which the tolerance-inducing mechanism may affect T- and B-cell functions of the chimera with respect to third-party antigens are yet to be determined.

DISINFESTATION

38230 (SAND—77-1970) **Parasites in soil/sludge systems.** Brandon, J.R. (Sandia Labs., Albuquerque, N.Mex. (USA)). Mar 1978. Contract EY-76-C-04-0789. 20p. Dep. NTIS, PC A02/MF A01.

The potential for the transmission of parasites, such as Entamoeba sp., schistosomes, and nematodes such as Ascaris sp., to man through the use of sewage sludges as fertilizer is reviewed. The eggs of Ascaris have been found to be the most resistant of these parasites to normal sludge treatment methods. Results of studies on the effectiveness of heat and ionizing radiation treatments reported show that a treatment of 55°C for 1 hour or more sufficiently reduces the number of viable Ascaris eggs in seeded sludge systems. An absorbed dose of 300 kilorads radiation is more than adequate for the same purpose. However, before an unequivocal statement can be made about the effectiveness of either of these treatments in reducing viable ova in real systems, certain qualifying factors must be investigated. There are conflicting reports on the radiation sensitivities of Ascaris eggs in different stages of development. Also, irradiation of composted sludge using an electron beam was unsuccessful in rendering all naturally-occurring Ascaris ova non-viable, even at 300 kilorads. The significant differences in radiation and heat sensitivities of Ascaris eggs in compost vs liquid systems points out the need to further investigate the effects of moisture levels on these sensitivities.

38231 (SAND—77-2045) **Cost and value of pathogen reduction for land application of sludges.** Sivinski, H.D.; Morris, M.E. (Sandia Labs., Albuquerque, N.Mex. (USA)). Mar 1978. Contract EY-76-C-04-0789. 30p. Dep. NTIS, PC A03/MF A01.

This paper discusses the general pressures that are forcing sewage sludge managers to reconsider land application of sludges where it is not already used; presents the cost of using gamma-radiation from the isotope cesium-137 for sludge disinfection; and documents the economic and social pressures that could compel a city such as Washington, D.C. to disinfect its compost before sale. Washington was chosen as an example because it is a city for which suitable compost marketing data are readily available. With these data it is reasonably straightforward to document the costs and benefits of radiation processing. The economic and social pressures that affect Washington are probably similar to those in many other areas where the radiation disinfection of dried sludge could provide the same disposal options.

RADIONUCLIDE EFFECTS - INTERNAL SOURCE

MAN

38232 Histopathologic studies of the liver following intravenous colloidal ^{198}Au therapy. Nelson, B.M.; Andrews, G.A.; Watson, E.E. (Oak Ridge Associated Universities, TN). *Radiology;* **127**: No. 1, 239-247(Apr 1978).

Histologic studies of liver tissue from 27 patients given up to 395 mCi (cumulative) of intravenous colloidal ^{198}Au showed no definite radiation injury and no correlation between hepatic abnormalities and dose. Demonstration of aggregates of colloidal gold in

the Kupffer cells was inconsistent, suggesting slow removal or dispersion. Although the liver ordinarily receives the highest radiation dose, the critical organ is the marrow. Results support the recent introduction of ^{198}Au to supplement teletherapy for certain neoplasms diffusely infiltrating the liver. Apparently the beta distribution minimizes endothelial injury in large vessels, which has been shown to be the cause of radiation hepatitis.

38233 Bone cancer among female radium dial workers. Latency periods and incidence rates by time after exposure: brief communication. Polednak, A.P. (Argonne National Lab., IL). *J. Natl. Cancer Inst.;* **60**: No. 1, 77-82(Jan 1978).

Bone cancer cases in 1250 women exposed to radium while working in the luminous watch-dial industry between 1913 and 1929 were analyzed for times of appearance ("latency periods") and incidence rates over time after first exposure. The lowest radium intake dose associated with bone cancer, among 751 women whose intake doses had been determined, was 202.5 μCi. Mean and median bone cancer latency periods tended to decline, but average survival among women without bone cancer also decreased with increasing intake level. Bone cancer incidence rates over time were compared in 2 intake-dose groups (200 to 749 and greater than or equal to 750 μCi) by means of an actuarial method that takes competing risks into account. Incidence rates were consistently higher in the higher intake-dose group versus the lower dose group at each 5-year period after first exposure. The variability in the odds ratios across the time periods was not statistically significant, and the actuarial method provided little evidence for an effect of intake dose on the pattern of incidence rate over time. With the use of similar methods, no significant variability was evident in the relative odds of bone cancer over time after exposure between one group of women first exposed to radium at less than 18 years of age and another group exposed when 18 or more years old.

ANIMALS

REFER ALSO TO CITATION(S) 38242, 38244

38234 Susceptibility of hematopoietic stem cells (CFU-s) to ^{55}Fe radiation damage. Reincke, U.; Brookoff, D.; Burlington, H.; Cronkite, E.P.; Pappas, N.; Zanjani, E. (Brookhaven National Lab., Upton, NY). *Radiat. Res.;* **74**: No. 1, 66-78(Apr 1978).

The susceptibility of CFU-s to radiation damage from ^{55}Fe was examined. In a preliminary experiment, irradiation emitted from ^{55}Fe-loaded erythrocytes was found to have no effect on erythroid colony formation during 72 hr of incubation. This demonstrated the low biological radiation effect of extracellular ^{55}Fe. Normal mouse bone marrow cell suspensions were then mixed with ^{55}Fe-loaded bone marrow, $^{55}FeCl_3$, or [^{55}Fe]desferrioxamine. No effect on CFU-s was found after up to 1 hr of incubation. However, when normal bone marrow mixed with [^{55}Fedesferrioxamine was frozen and stored at -196°C, measurable damage to CFU-s progressed with increased storage time. Normal marrow mixed with stable [^{55}Fe]desferrioxamine showed no loss of CFU-s over 13 storage weeks. In subsequent experiments direct radiation damage to CFU-s was measured by freezing bone marrow 4 to 24 hr after ^{55}Fe injection of donor mice and determining viable CFU-s after 1 to 60 weeks. Logarithmic loss functions typical of radiation damage were observed with half times of 3.0 and 4.4 weeks. In vivo ^{55}Fe radiation dose to CFU-s was estimated using the slope of CFU-s loss curves obtained in frozen storage. It was derived that intravenous injection of mice with 1.4 mCi $^{55}FeCl_3$ (ca. 80 μCi/g body weight) subjects CFU-s to damage that could logically be ascribed to 0.37 rad/hr and 0.54 rad/hr after 4 and 24 hr, respectively.

38235 Acute toxicity of beta-emitting radionuclides that may be released in a reactor accident and ingested. Sullivan, M.F.; Ruemmler, P.S.; Beamer, J.L.; Mahoney, T.D.; Cross, F.T. (Battelle Pacific Northwest Labs., Richland, WA). *Radiat. Res.;* **73**: No. 1, 21-36(Jan 1978).

Suckling, weanling, and adult rats received ^{106}Ru—^{106}Rh by gavage and adult beagle dogs ingested ^{106}Ru—^{106}Rh to determine the toxicity of this high-energy (1.4 MeV av) β-emitting nuclide pair. The LD_{50}'s for suckling, weanling, and adult rats were 1.5, 18, and 9.0 mCi/kg, respectively. Adult rats were given ^{147}Pm by gavage to determine if a low-energy (0.06 MeV av) β emitter could also cause death by damaging the bowel. The LD_{50} of ^{147}Pm in rats was about 5 Ci/kg. The calculated radiation doses absorbed in the target cells at the LD_{50} level were approximately the same for the two radionuclides (3500 rad), although the doses at the mucosal surface differed widely. The LD_{50} for ^{106}Ru—^{106}Rh in dogs was about 3.5 mCi/kg. Dosimeters placed beneath the mucosa in dogs indicated that the radiation dose to the target cells that caused death from ^{106}Ru—^{106}Rh was about the same as it was for rats. The signs of intestinal injury, their duration, and the probabilities of tissue repair were much different in the dog than in the rat. The midcolon and lower colon of dogs were usually denuded at focal sites after ingestion of 2.5 to 4.0 mCi/kg, and frequently that damage was irreversible. The fatal consequence of severe mucosal damage was averted in two dogs by colectomy and an ileorectal anastomosis.

38236 Dose to the GI tract from ingested insoluble beta emitters. Cross, F.T.; Endres, G.W.R.; Sullivan, M.R. (Battelle Pacific Northwest Labs., Richland, WA). *Radiat. Res.;* **73**: No. 1, 37-50(Jan 1978).

The distribution of dose rate within the walls of tissue-equivalent cylinders of various radii, containing material uniformly contaminated with insoluble beta emitters, was calculated using Berger's tables of scaled absorbed-dose distribution. The dose-rate calculations span the beta energy range 0.22 to 3.54 MeV and radii range 0.05 to 5.00 cm to simulate the size of the GI tract of animals used in studies of GI lethality. In addition, TL dosimeters were implanted in the GI tract to measure the dose distributions experimentally. Approximate LD_{50} doses of various radionuclides were determined for both the rat and beagle dogs based upon the physics of the radiations and the clinical observations of the animals.

38237 Inhalation carcinogenesis of high-fired $^{238}PuO_2$ in rats. Sanders, C.L.; Dagle, G.E.; Cannon, W.C.; Powers, G.J.; Meier, D.M. (Battelle Pacific Northwest Labs., Richland, WA). *Radiat. Res.;* **71**: No. 3, 528-546(Sep 1977).

Wistar rats were given a single, nose-only exposure to freshly prepared high-fired $^{238}PuO_2$ particles (activity median aerodynamic diameter of $^{238}PuO_2$, 1.8 +- 0.6 μm), and the rats were observed over their life span. A total of 344 rats were examined: 294 exposed to $^{238}PuO_2$ and 50 serving as unexposed controls. A significantly increased incidence of malignant tumors was found only in the lung. Most of the lung tumors were adenocarcinomas followed in abundance by squamous cell carcinomas. The incidences of lung tumors were 0 in unexposed controls, 0.8 percent at an initial alveolar deposition of 0.14 nCi ^{238}Pu, 7.5 percent at 11 nCi, 60 percent at 220 nCi, and 19 percent at 890 nCi. High-fired $^{238}PuO_2$ appeared to be less effective in producing lung tumors in the Wistar rat than was $^{239}PuO_2$, due possibly to the smaller amount of lung tissue irradiated by $^{238}PuO_2$ particles than by $^{239}PuO_2$ particles.

MICROORGANISMS

38238 Tritium-induced lethal and genetic changes in Saccharomyces cerevisiae. Burki, H.J. (Univ. of California, Berkeley); Moustacchi, E. *Radiat. Res.;* **71**: No. 3, 635-640(Sep 1977).

Haploid and diploid yeast cell strains of Saccharomyces cerevisiae were labeled with [6-^{3}H]uracil, a general precursor of nucleic acids. Damage from tritium decay was accumulated at 4°C. Tritium-induced reproductive death, gene conversion, and mutation were compared to the same effects produced by gamma radiation. In all cases, the results were qualitatively similar to gamma rays, suggesting that the genetic hazard from incorporated environmental tritium in eucaryotic cells is similar to an equivalent dose of x rays. The most sensitive genetic assay for the effects of tritium decay in diploid yeast is the induction of genetic recombination. This induction of genetic recombination also occurs during normal growth of cells at 30°C at total activities of as little as 1 μCi/ml. Therefore, many experiments, using small amounts of tritium precursors, may be affected by tritium-induced genetic recombination. This effect of tritium should be considered in experimental designs, using tritium isotopes.

NUCLIDE KINETICS AND TOXICOLOGY

MAN

38239 (NUREG/CR—0010) **Radiation exposure and risk estimates for inhaled airborne radioactive pollutants including hot particles. Annual progress report, July 1, 1976—June 30, 1977.** Mewhinney, J.A. (Lovelace Foundation for Medical Education and Research, Albuquerque, N.Mex. (USA). Inhalation Toxicology Research Inst.; Lovelace Biomedical and Environmental Research Inst., Albuquerque, N.Mex. (USA)). Jan 1978. 150p. NTIS $8.00.

The primary object of this project is to conduct confirmatory research on the sources, biological fate, and predicted health consequences of airborne radioactivity which may be released in normal operations or under accident conditions in the nuclear fuel cycle. Research activities include: assessment of the relative potential hazard of various industrial operations based on existing data from field characterization of airborne material produced and likely to be released; laboratory physical and chemical characterizations of selected aerosol samples to assess better their potential hazards following inhalation; inhalation exposure of animals conducted under conditions which reproduce original aerosol characteristics to study the behavior and dose patterns associated with different compounds and forms; the use of a common experimental protocol to maximize the comparison among species; direct comparison of dose patterns and resulting biological effects between these studies and other studies

using laboratory-produced idealized aerosols; close working links with complementary research efforts in the characterization of industrial, plutonium-containing aerosols and the development of therapeutic procedures for possible use after accidental inhalation exposure; and synthesis of information derived from these studies into a data base to provide improved estimates of health risk to humans after inhalation of complex aerosolized materials.

ANIMALS

REFER ALSO TO CITATION(S) 37953, 38222, 38235, 38236

38240 (ANL—77-55, pp 99-109) **Therapy of metal poisoning.** 1976.

In Division of Biological and Medical Research annual report, 1976.

Progress is reported on methods for the decorporation of toxic metals (Pu and Pb) deposited in the skeleton and liver. Studies in mice showed good results using the divinyl ether-maleic anhydride pyran copolymer (XA 146-85-2) (used clinically as an antitumor and antiviral drug) or acrylic acid-isobutyl vinyl ether copolymer (EMH-217) as adjuncts to DTPA for the decorporation of ^{236}Pu, ^{239}Pu, ^{242}Pu, and ^{244}Pu, whose specific activities differ by more than 10^7. The therapeutic efficiency of $CaNa_3$ DTPA for the removal of Pb from the liver of mine was demonstrated. The effectiveness of DTPA alone for reduction of ^{239}Pu deposited on the gonads of two strains of mice and of dogs was demonstrated autoradiographically and histologically.

38241 (UCD—472-124, pp 163-164) **Changes in ^{131}I metabolism in rats consequent to chronic ingestion of ^{129}I.** Book, S.A.; McNeill, D.A. Oct 1977.

In Annual report, fiscal year 1977.

Chronic ingestion of ^{129}I in high amounts suppressed thyroidal uptake of ^{131}I in young rats. Iodine-131 uptake was depressed 1 week after ^{129}I feeding was begun, and remained so for the duration of the study.

38242 **$^{239}PuO_2$ aerosol inhalation exposure of miniature swine.** Karagianes, M.T.; Beamer, J.L.; Clary, A.J.; Craig, D.K.; Decker, J.R.; Cannon, W.C. (Battelle Pacific Northwest Labs., Richland, WA). *Radiat. Res.;* **74**: No. 1, 79-87(Apr 1978).

Techniques were developed for inhalation exposure of miniature swine to radioactive aerosols. The anesthetized animals were exposed to $^{239}PuO_2$ aerosols in dog inhalation chambers which were modified to accommodate the larger size of the swine. A sling cart, for transporting and restraining the pigs, and special face masks, to allow intranasal exposure only, were designed and fabricated for this feasibility study. Four swine were exposed to the aerosols; they were killed at 10, 13, 30, and 90 days postexposure. Plutonium was cleared from the body in a biphasic pattern with a biological retention halftime of a few days for 90% of the initial alveolar burden, and 50 days or longer for the remainder. Eighty-three to 96% of plutonium retained in the body at necropsy was in the lung and pulmonary lumph nodes.

38243 **Action of DTPA on hepatic plutonium. I. Quantitation of the DTPA-induced biliary excretion of plutonium in the rat.** Bhattacharyya, M.H.; Peterson, D.P.; Lindenbaum, A. (Argonne National Lab., IL). *Radiat. Res.;* **74**: No. 1, 179-185(Apr 1978).

Rats received an intravenous injection of 0.1 μCi of ^{239}Pu-citrate (approximately 0.5 μCi/kg). At 24 hr after Pu injection, the bile ducts were cannulated and diethylenetriaminepentaacetic acid (DTPA, 0.25 mmole/kg) was injected intravenously. The amount of Pu appearing in the bile during the first 24 hr after DTPA injection was determined. In addition, the decrease in Pu content of the liver 24 hr after DTPA administration was measured in both bile duct-cannulated and noncannulated rats and compared to the amount of Pu appearing in the bile. Bile collected from control rats receiving saline instead of DTPA contained 0.40 +- 0.08 nCi of Pu (mean +- SE, n = 3), while bile collected for 24 hr after DTPA administration contained 7.2 +- 0.4 nCi Pu (mean +- SE, n = 6). Thus, DTPA administration brought about a striking increase in biliary Pu excretion. The mean decrease in liver Pu content 24 hr after DTPA administration to rats whole bile ducts were not cannulated was 7.4 +- 1.4 nCi (mean +- SE, n = 6); the corresponding decrease calculated for three bile duct-cannulated rats was 7.2 +- 1.3 nCi. We have demonstrated, therefore, a nearly exact correspondence between the amount of Pu removed from the liver and that appearing in the bile following DTPA administration to the rat.

38244 **Variation of radon retention parameters for radium-burdened dog skeletons as a function of exposure age and dosage level.** Parks, N.J.; Pool, R.R.; Williams, J.R. (Univ. of California, Davis). *Radiat. Res.;* **73**: No. 2, 274-287(Feb 1978).

Radium-226 was administered to 36 beagles at various levels in eight semimonthly injections at ages 60 to 160, 120 to 220, or 435 to 535 days. Approximately 400 individual radon retention values were obtained from γ-ray spectra taken at intervals over the life span of the animals. Radon retention was fitted by regression analysis to a power function of the form At/sup b/ (t = time after injection midpoint). Mean values and associated standard errors of the parameters anti A (SE) and anti b (SE), for animals of both sexes given 10 μCi/kg body weight at injection midpoint ages of 110, 170, and 485 days were [3.11 (0.15 SE); 0.293 (0.006 SE)], [5.31 (0.38 SE); 0.214 (0.006 SE)], and [6.08 (0.21 SE); 0.200 (0.007 SE)], respectively. The smaller coefficients, A (t = 1-day intercept), and larger exponents, b (rate parameter), found for earlier ages at injection are attributed to age-dependent differences in the mineral density of bone and the intrabone radium distribution pattern. The mean values of the parameters for animals receiving total dosages < or = 1.12-μCi/kg body weight at a midpoint age of 485 days were [7.88 (0.31 SE); 0.153 (0.005 SE)]. The differences in retention function parameters between the higher and lower ^{226}Ra dosage levels are interpreted in terms of radiation damage to bone which alters the degree of mineralization in regions of radium deposition.

38245 **Retention of plutonium in hepatocytes and sinusoidal lining cells isolated from rat liver.** Grube, B.J.; Stevens, W.; Atherton, D.R. (Univ. of Utah, Salt Lake City). *Radiat. Res.;* **73**: No. 1, 168-179(Jan 1978).

The distribution of Pu in the extravascular and cellular compartments of rat liver was studied following the intravenous injection of ^{239}Pu(IV) citrate, 0.9 μCi/kg body wt. The quantity of Pu in the whole liver reached a maximum at 2 days postinjection (P.I.) and then declined. This loss from the liver can be expressed by a two-component exponential of the form L/sub (rat t>2d)/ = 29e /sup -0.29t/ + 4e/sup -0.022t/, where L is the percentage of injected Pu in the liver at t days P.I. Significant quantities of both protein and Pu were found in the perfusate of livers perfused with modified Hanks buffer. The amounts of Pu in isolated and purified hepatocytes and sinusoidal lining cells were determined following digestion by collagenase of the buffer-perfused liver. The retention of ^{239}Pu by the two cell populations declined, as did that of the whole liver. However, Pu was lost from hepatocytes more rapidly than it was from sinusoidal lining cells so that by 1 day P.I. the amount of Pu per milligram of protein in sinusoidal cells was greater than that in hepatocytes. The association of Pu with cells of both populations was verified by autoradiography. Fractionation of hepatocytes into subcellular components indicated that the amount of Pu in each fraction decreased at the same rate as the amount in the whole liver.

PLANTS

REFER ALSO TO CITATION(S) 38029, 38033

THERMAL EFFECTS

MICROORGANISMS

REFER ALSO TO CITATION(S) 38250

INVERTEBRATES

REFER ALSO TO CITATION(S) 38250

38246 **Reservoir manipulations and benthic macroinvertebrates in a prairie river.** Gore, J.A. (Univ. of Montana, Missoula). *Hydrobiologia ;* **55**: No. 2, 113-123(18 Aug 1977).

Samples were taken on the Tongue River, Montana, USA, during 1974 and 1975 to determine the distributions and abundances of the benthic fauna after various reservoir manipulations. The upper cold water section, influenced by hypolimnial discharge from the Tongue River Reservoir, was impoverished in insect fauna and dominated by the molluscs Physa and Sphaerium. The lower warm water sections of the river contained two communities determined primarily by turbidity and periphyton cover. The upper warm water area was dominated by Strophopteryx and hydropsychid caddis larvae. The lower river was dominated by Cheumatopsyche. The summer fauna, in the warm water area, was dominated by short-lived mayfly species. During the summer, 1975, the cold water section was invaded by many insects due to warming of the area when no hypolimnion was formed in the reservoir. Invasion was apparently due to increased thermal fluctuations which caused diapause eggs to hatch and influenced the upstream migration of older nymphs and larvae. Results of drift and distributional samples after closure of the Tongue River Reservoir Dam for repairs showed that massive drift of all invertebrates began at a discharge of 130 c.f.s. (3.68 m^3/sec), a drop from 190 c.f.s. (3.38 m^3/sec) over a period of three days. Community composition was radically altered by reduced discharge.

38247 Effects of temperature on photosynthesis and respiration in hermatypic corals. Coles, S.L.; Jokiel, P.L. (Hawaii Inst. of Marine Biology, Kaneohe). *Mar. Biol;* **43**: No. 3, 209-216(1977).

Photosynthesis and respiration rates of the reef corals Pocillopora damicornis (Linn.), Montipora verrucosa (Lamarck), Porites compressa Dana and Fungia scutaria Lamarck were measured under controlled temperatures. Results indicate that coral metabolism is closely adapted to ambient temperature conditions. Tropical corals measured at Enewetak, Marshall Islands, showed greater primary production compared to maintenance requirements at elevated temperatures than did subtropical varieties of the same species in Hawaii. Photosynthesis:respiration (P:R) ratios were significantly and negatively related with temperature between 18° and 31°C for all Hawaiian corals, whereas at Enewetak this ratio generally showed a curvilinear relationship for this temperature range. Extrapolations of P:R regressions on temperatures to a value of 2.0 (estimated as a minimum required for long-term functional autotrophy) coincide for Hawaiian specimens with published upper lethal temperatures. Extrapolation of P:R regressions for Enewetak specimens at temperatures above 25°C suggests lethal temperatures for these corals to be 2 to 5 C° higher than for Hawaiian corals, in good agreement with recent experimental findings. Interspecific differences in P:R temperature regressions for Hawaiian corals corelating with upper lethal temperature tolerances are described.

38248 Effects of temperature on the mortality and growth of Hawaiian reef corals. Jokiel, P.L.; Coles, S.L. (Hawaii Inst. of Marine Biology, Kaneohe). *Mar. Biol;* **43**: No. 3, 201-208(1977).

Three common spcies of Hawaiian reef corals, Pocillopora damicornis (L.), Montipora verrucosa (Lamarck) and Fungia scutaria Lamarck, were grown in a temperature-regulated, continuous-flow seawater system. The skeletal growth optimum occurred near 26°C, coinciding with the natural summer ambient temperature in Hawaii, and was lowest at 21° to 22°C, representing Hawaiian winter ambient. Levels of approximately 32°C produced mortality within days. Prolonged exposure to temperatures of approximately 30°C eventually caused loss of photosynthetic pigment, increased mortality, and reduced calcification. Corals lived only 1 to 2 weeks at 18°C. The corals showed greater initial resistance at the lower lethal limit, but ultimately low temperature was more deleterious than high temperature. Results suggest that a decrease in the natural water temperature of Hawaiian reefs would be more harmful to corals than a temperature increase of the same magnitude.

38249 Some aspects of the thermal tolerance of Trichomya hirsuta (Mollusca: Bivalvia) of Eastern Australia. Wallis, R.L. (Univ. of New South Wales, Kensington, Australia). *Mar. Biol;* **43**: No. 3, 217-223(1977).

The upper temperature tolerance range for Trichomya hirsuta L. is described for acclimation temperares of 10° to 32°C at 30% S. Changes in thermal resistance with time are described along with the incipient lethal temperatures. The eurythermicity for the species is 240.7 C°-squared. The ultimate upper incipient lethal temperature is 35.1°C. Definition of the incipient sublethal temperature is given, and is equal to 32°C. Diet effects are shown not to be significant in short-term lethal experiments, but indicate that unfed mussels reduce their resistance after prolonged exposure to high temperatues. Size was also shown to have no effect on resistance and tolerance. A comarison of the tolerance triangle of T. hirsuta with those of the temperate species Mytilus edulis and Mya arenaria revealed that the 24-h LT_{50} minus 2.2 C° approximates the incipient lethal temperature. The eurythermicities of the temperate species are Mytilus edulis, 363 C°-squared; and Mya arenaria, 415 C°-squared.

VERTEBRATES

38250 Thermal effects. Coutant, C.C.; Talmadge, S.S. (Oak Ridge National Lab., TN). *J. Water Pollut. Control Fed.;* **49**: No. 6, 1369-1425(Jun 1977).

The 1976 literature on thermal effects was reviewed under the following categories: reviews; power plant studies; producers; consumer reproduction, development, morphology, distribution, thermal tolerance, growth, feeding, activity, oxygen metabolism, temperature and other stresses; decomposers; diseases and parasites and beneficial uses. Many of the studies are summarized in tabular form.

38251 Distribution and temperature adaptation in the teleost fish genus Gibbonsia. Davis, B.J. (San Francisco State Univ.). *Mar. Biol;* **42**: No. 4, 315-320(1977).

Along the California coast there are three intertidal species of the genus Gibbonsia (G. elegans, G. metzi, G. montereyensis). These species have distinct but overlapping distributions. Collections were made seasonally from three areas. Each collection was divided into two groups--a critical thermal maximum and minimum were determined for on group and the other group was tested after a 3 week acclimation period. The three species showed genetically different adaptation abilities and these were correlated with species differences in latitudinal distributions. The species that experiences the widest seasonal temperature range proved capable of anticipatory adjustment to temperature while the two experienceing small seasonal changes showed only reactive adjustments. The species with the widest distribution showed the greatest ability to adapt to temperature extremes. After 1 week acclimation all three species demonstrated different mechanisms for heat and cold adaptation.

38252 Critical thermal maxima of two species of estuarine fish. Everich, D.; Gonzalez, J.G. (Environmental Protection Agency, Narragansett, RI). *Mar. Biol;* **41**: No. 2, 141-145(1977).

Critical thermal maxima (CTM) were determined for winter flounder (Pseudopleuronectes americanus, Walbaum) and scup (Stenotomus chrysops, L.), acclimated to ambient water temperature or constant increments above ambient. The acclimation regimes simulated natural environment by tracking the temperature fluctuations in Point Judith Pond, a small Rhode Island estuary. An elevation in CTM from 30.2° to 35.6°C was observed for scup as the mean acclimation temperature increased from 14.8° to 22.2°C. CTM for founder increased from 26.4° to 32.4°C over an acclimation range of 4.2° to 23.0°C. The use of CTM studies for predicting the effects of heated effluents is discussed.

CHEMICALS METABOLISM AND TOXICITY

REFER ALSO TO CITATION(S) 36687, 36740, 36799, 36804, 38084, 38089

38253 Cleaning agents for oiled wildlife. Berkner, A.B.; Smith, D.C.; Williams, A.S. (International Bird Rescue Research Center, Berkeley, CA). pp 411-415 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

Attempts to save oiled wildlife cannot be successful unless appropriate treatment is given. One of the more critical areas of rehabilitation is the selection and correct use of a suitable cleaning agent. The advantages and limitations of detergents and solvents are discussed with respect to the types of wildlife affected, the types of oil involved, and the available equipment and facilities. Seven commercial detergents out of 22 tested are ranked in order of their effectiveness in removing eight specific types of oil. Optimal concentrations and available toxicity data are also given. Solvents that have been successfully used are listed along with other solvents that appear promising on the basis of their composition and physical parameters. Further evaluations of cleaning agents and additional basic research are still needed.

38254 Oil pollution and tropical littoral communities: biological effects of the 1975 Florida Keys oil spill. Chan, E.I. (National Oceanic and Atmospheric Administration, Washington, DC). pp 539-542 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

This study reports biological effects of the July 1975 oil spill in the Florida Keys for a one-year period. Floating seagrass served as a natural sorbent for oil and stranded in the intertidal zone. A soluble component of oil, or possibly an organic cleaning solvent, leaching from this debris, was probably responsible for a mass mortality of subtidal echinoderms on the rocky platform. Several crab species were eliminated from the rocky shores, mangrove fringes, and Batis marsh communities for several months. Subtidal pearl oysters (Pinctada radiata) from the grass flat community suffered extensive mortalities, also attributable to a soluble component of oil. Red mangrove (Rhizophora mangle) seedlings on the fringe and in the mangrove swamp, sustaining greater than 50 percent oiling of their leaves, were killed. Dwarf black mangroves (Avicennia nitida) with greater than 50 percent oiling of pneumatophores also died, as did some where the substrate remained oiled one year later. Elevated temperatures, exceeding lethal limits for many intertidal organisms, were observed in oil-covered substrates. Oil persisted in the substrate of rocky shores and mangrove-marsh areas for at least one year after the spill.

38255 Continuous flow bioassay system for the exposure of marine organisms to oil. Hyland, J.L.; Rogerson, P.F.; Gardner, G.R. (Environmental Protection Agency, Narragansett, RI). pp 547-550 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

A continuous flow-through bioassay system is described for exposing marine test organisms and their various life stages to oil. The apparatus consists of two principal stages—one for administering the water-accommodated fractions of oil (WAF) and the second for administering "whole" oil fractions (WF), including the soluble as well as nonsoluble fractions. The oil-contaminated effluent from the system first passes through a chamber to skim off separated oil and finally through a filter which lowers the oil concentration to below one part per million (1 ppM). Short-term lethal and chronic sublethal bioassays of several months duration were conducted in the system and are summarized briefly herein. Biological effets observed during bioassays have ranged from lethal toxicity at oil concentrations of approximately 10 parts per million (ppM) to sublethal behavioral modifications at approximately 10 parts per billion (ppb).

38256 Flow-through system for chronic exposure of aquatic organisms to seawater-soluble hydrocarbons from crude oil: construction and applications. Roubal, W.T.; Bovee, D.H.; Collier, T.K.; Stranahan, S.I. (National Marine Fisheries Service, Seattle). pp 551-555 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

Flow-through systems circumvent problems associated with static systems for exposing aquatic organisms to water-soluble hydrocarbons by providing an uninterrupted supply of water-soluble fraction with minimal compositional variations. Moreover, there is little accumulation of deleterious excretory products. Yet the design of a flow-through system for crude petroleum poses practical problems. All exposed surfaces of equipment become coated with thick oily residues, which, if ignored, result in changes in water flow rates and in levels of soluble hydrocarbons. To circumvent such problems, a modular system was built which can be adjusted to compensate for oil accumulation. Analysis of the water-soluble fraction prepared from Prudhoe Bay crude oil showed it to contain primarily low molecular weight aromatic compounds as follows (average concentration, ppM): benzene, 0.26; toluene, 2.45; total xylenes, 1.73; C_3- and C_4-substituted benzenes, 0.26; naphthalene, 0.01; l-methyl naphthalene, 0.02; 2-methyl naphthalene, 0.02; C_2-substituted naphthalenes, 0.05; and C_3-substituted naphthalenes, 0.03. Hydrocarbon analysis of muscle tissue from coho salmon exposed to a water-soluble fraction for 5 weeks is presented.

CELLS

REFER ALSO TO CITATION(S) 37952, 38134, 38203, 38219

38257 Consequences of bisulfite exposure in primary chick embryo fibroblast in culture. Chin, S.; Bissell, M.J.; Bassham, J.A. (Univ. of California, Berkeley). *Bull. Environ. Contam. Toxicol.;* **18**: No. 6, 749-757(Dec 1977).

Bisulfite (HSO_3^-) was administered to chick embryo fibroblasts in culture. Incorporation of HSO_3^-/SO_3^{2-} was rapid and dependent on the bisulfite concentration. Hexose uptake, glucose catabolism, and membrane permeability were not affected at the concentrations examined. Nevertheless, cell growth and the rate of DNA synthesis decreased after 18 hours of exposure to HS_3^-/SO_3^{2-} levels as low as 0.1 mM. These results indicate that the primary site of action of bisulfite is in the pathway of DNA synthesis.

MICROORGANISMS

REFER ALSO TO CITATION(S) 38085, 38092, 38148, 38165, 38292, 38298

38258 (CONF-780327—1) **Genetic toxicity testing of complex environmental effluents.** Larimer, F.W.; Epler, J.L. (Oak Ridge National Lab., Tenn. (USA)). 1978. Contract W-7405-ENG-26. 10p. Dep. NTIS, PC A02/MF A01.

From 4. hazardous waste research symposium; San Antonio, TX, USA (3 Mar 1978).

The Salmonella histadine-reversion system and other genetic test systems were used to assay the mutagenic potential of crude synthetic oils and natural crude oils as exemplary complex mixtures. Extracts and leachates from particulate matter were also tested. Mutagenicity data on isolated or suspected organic components are presented. The results support the use of the short-term genetic tests in examining curde mixtures and point to the advantages of coupling the bioassays with chemical fractionation.

38259 (SAND—77-1498) **Methods to inactivate enteric viruses in wastewater sludge.** Ward, R.L.; Ashley, C.S. (Sandia Labs., Albuquerque, N.Mex. (USA)). Mar 1978. Contract EY-76-C-04-0789. 24p. Dep. NTIS, PC A02/MF A01.

Sewage sludge contains an agent that causes inactivation of poliovirus at temperatures at least as low as 4 C. This agent has been identified as ammonia. The mechanism by which ammonia inactivates poliovirus is to stimulate cleavage of viral RNA within the intact virion. Sludge also contains material that is protective of poliovirus against heat inactivation but its effect can be reversed by ammonia. The protective substance may be the same component of sludge that greatly reduces the temperature required to inactivate reovirus. This substance apparently becomes concentrated during the drying of sludge but was not found in composted sludge which suggests that it is destroyed during composting.

38260 Nitrogen cycling in a marine planktonic food chain: nitrogen fluxes through the principal components and the effects of adding copper. Harrison, W.G. (Univ. of California, San Diego, La Jolla); Davies, J.M. *Mar. Biol.;* **43**: No. 4, 299-306(1977).

Nitrogen cycling in a natural planktonic food chain was followed before and after perturbation by copper (10 $\mu g\ l^{-1}$). Observations were separated into effects from artificial containment of the food chain and effects from the addition of copper. An initial reduction of seston-N and subsequent recovery, uniformly high settling rates of suspended particulate-N, and general decrease in zooplankton-N were attributed to the physical limitations imposed by the enclosures (e.g. elimination of normal mixing processes). Acute inhibition of nitrate assimilation by the seston, acute elevation of seston-N settling and chronic inhibition of zooplankton feeding, along with accelerated decline in zooplankton stocks, were attributed to copper stress. Since zooplankton stocks and fluxes were most drastically affected by copper, its overall effect on N-cycling through the planktonic food chain would depend largely upon the importance of zooplankton in regulating the production of the remaining seston.

PLANTS

REFER ALSO TO CITATION(S) 36689, 38082

38261 (CONF-780227—6) **Environmental testing.** Gehrs, C.W.; Parkhurst, B.R.; Shriner, D.S. (Oak Ridge National Lab., Tenn. (USA)). 1978. Contract W-7405-ENG-26. 20p. Dep. NTIS, PC A02/MF A01.

From Symposium on application of short-term bioassays in the fractionation and analysis of complex environmental mixtures; Williamsburg, VA, USA (21 Feb 1978).

Coupling of chemical separation and fractionation with environmental testing is able to identify those materials most biologically active, at least, in acute toxicity. In the case of the (SRC) solvent refined coal effluent the primary activity was attributed to the acidic organic fraction, where the phenolics are located. Because of the relative removal efficiency of phenolics through chemical stripping and biological treatment, near-field acute toxicity from effluent releases would not be expected from aqueous effluents released from a facility similar to the SRC pilot plant.

38262 Is hydrogen fluoride mutagenic in plants. Temple, P.J. (Ontario Ministry of the Environment, Toronto); Weinstein, L.H. *J. Air Pollut. Control Assoc.;* **28**: No. 2, 151-152(Feb 1978).

An experiment was designed to study the cytogenetic effects of HF on tomato plants using five-week old Lycopersicon esculentum Mill. var. "Bonny Best". Twelve plants were grown in each of three chambers, comprising a high F treatment, low F treatment, and control. Thirty-day average concentrations of HF in the chambers were 6.7 ppB (high F), 1.2 ppB (low F), and control (no added F). Typical symptoms of HF-induced foliar injury were observed after two weeks in the high F chamber; no injury was seen on low F treated or control plants. No differences were found in numbers of fruit produced by plants exposed to the different levels of HF. Although seed weight was less in fluoride-treated plants than in control plants, these differences were not statistically significant. No significant differences were found in rates of seed germination among treatments, either on moistened filter paper, or in soil. None of the phenotypic or chromosomal abnormalities reported by Mohamed were seen in the seedlings raised in the experiment. Experiments using onion (Allium cepa L.) root-tips exposed to high concentrations of fluoride in aqueous solution produced different results. After immersion for 24 hr in 10^{-2} M NaF or 10^{-2} M NaCl, the number of aberrations observed in metaphase chromosomes was greater in samples exposed to NaF than NaCl.

38263 Carbon dioxide correlation with oxidant air pollution in the San Bernardino Mountains of California. Coyne, P.I.; Bingham, G.E. (Univ. of California, Livermore). *J. Air Pollut. Control Assoc.;* **27**: No. 8, 782-784(Aug 1977).

Ambient CO_2 concentrations in the San Bernardino Mountains fluctuate directly with the level of air pollution and are

generally highest when O_3 levels are highest. Published laboratory studies employing unstressed plants and plants stressed by nitrogen and sulfur oxides have shown that CO_2 concentrations above normal ambient levels do have a stimulatory effect on net photosynthesis. This stimulatory effect can wholly or partially offset pollutant injury, depending on CO_2 and pollutant levels as well as other environmental conditions. Clearly this potential amelioration of pollutant effects must be taken into account in any attempt to understand and predict the effects of pollutants on plants.

38264 Use of biological indicator organisms to monitor trace metal pollution in marine and estuarine environments: a review. Phillips, D.J.H. (Dept. of Zoology, Uppsala). *Environ. Pollut. (London);* **14**: No. 4, 281-317(Aug 1977).

The use of biological indicator organisms to define areas of trace metal pollution appears most attractive, as these organisms not only concentrate metals from water, allowing inexpensive and relatively simple analysis, but they may also represent a moving time-averaged value for the relative biological availability of metals at each site studied. However, the use of indicator organisms introduces biological variables which are not present in physico-chemical studies of water or sediments. These variables merit consideration inasmuch as they may affect the results of indicator surveys for trace metals. In addition, different indicator organisms measure different portions of the total trace metal load on an ecosystem. The present state of knowledge on the use of indicator organisms to study trace metal pollution is reviewed, with particular reference to the use of macroalgae, bivalve molluscs and teleosts. It is suggested that the macroalgae and bivalve molluscs are the most efficient and reliable indicators developed to the present time. It is further suggested that the effects of sampling and environmental variables have been largely overlooked, and that further study in the field and in the laboratory is necessary before the results of surveys using biological indicator organisms can be relied upon.

38265 Cadmium, lead, and nickel content of Lycoperdon perlatum pers. in a roadside environment. McCreight, J.D.; Schroeder, D.B. (Univ. of Connecticut, Storrs). *Environ. Pollut. (London);* **13**: No. 4, 265-268(Aug 1977).

Twenty specimens of the "gem-studded" puffball, Lycoperdon perlatum Pers., sampled along Interstate Highway 86 East, north of Storrs, Connecticut, were found to be contaminated with cadmium and lead. Cadmium concentrations ranged from 0.00 to 5.34 ppM in different parts of the sporophores. Similarly, lead concentrations ranged from 0.00 to 80.98 ppM. Nickel was detected in only one sample at a concentration of 2.37 ppM.

38266 Influence of zinc on lotic plants. II. Environmental effects on toxicity of zinc to Hormidium rivulare. Say, P.J.; Whitton, B.A. (Univ. of Durham, Eng.). *Freshwater Biol.;* **7**: No. 4, 377-384(Aug 1977).

The toxicity of zinc to Hormidium rivulare Kutz. in laboratory culture media is decreased by rises in the levels of magnesium, calcium and phosphate, and increased by rises in pH and cadmium. The effects of all these are sufficiently marked that they may be expected to have considerable importance in the field. In contrast, assays with sodium, chloride and sulphate showed no detectable influence of these ions on zinc toxicity. When applied at higher concentrations, calcium was always more effective than magnesium, but the reverse was sometimes true at lower concentrations. Both magnesium and phosphate were more effective in reducing zinc toxicity with zinc-tolerant populations than with zinc-sensitive ones. Cadmium was highly toxic, either alone or in combination with zinc; however, calcium had a proportionately greater effect in reducing cadmium toxicity than zinc toxicity. The toxic effects of zinc and cadmium were synergistic, and it seems probable that the presence of cadmium at levels of 0.01 mgl^{-1} and above will usually lead to a significant increase in the toxicity of any zinc also present. Cadmium (in the absence of zinc) was 34 times more toxic than zinc to a zinc + cadmium sensitive population, and 15.5 times more toxic to a zinc + cadmium tolerant population. Because of the synergistic response, cadmium had an even greater effect in the presence of zinc.

38267 Effects of drill mud on sediment clearing rates of certain hermatypic corals. Thompson, J.H.; Bright, T.J. (Texas A and M Univ., College Station). pp 495-498 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

The hermatypic corals Diploria strigosa, Montastrea annularis and Montastrea cavernosa were subjected to large uniform doses of four sediments; used whole drill mud, barite, aquagel and calcium carbonate (a sediment occurring naturally on coral reefs). The rates at which each species cleared itself of the sediment covers were measured in square millimeters per hour. No corals were able to remove the used whole drill mud, but all could rid themselves effectively of the other three sediments. Diploria strigosa exhibited a generally faster clearing rate than the other two species, but there was no difference in the rates at which any one species cleared itself of either barite, aquagel or calcium carbonate. It is suspected that the dramatic effect of used whole mud, which also caused mortality, was due to dissolved chemical components which we have yet to identify.

38268 Assessment of plant-available cadmium in soils. Symeonides, C.; McRae, S.G. (Wye Coll., Ashford, Eng.). *J. Environ. Qual.;* **6**: No. 2, 120-123(1977).

Three pot experiments were conducted to test the utilization of ash from different kinds of animal manures and vegetative crop residues as source of phosphorus fertilizer. Corn (Zea mays L.) yield grown on phosphorus-deficient soil (Aiken loam), treated with acidified ash at rates equivalent to 200, 400, 800, and 1,200 ppM P, responded almost like concentrated super phosphate (CSP) at the same rates. Yields from pots treated with ash acidified at 50% of its base equivalent were slightly less than those at 100% acidification. The leached acidified ash of agricultural waste materials proved to be a comparable source to CSP fertilizer.

38269 Growth and water movement in silver maple seedlings affected by cadmium. Lamoreaux, R.J.; Chaney, W.R. (Purdue Univ., Lafayette, IN). *J. Environ. Qual.;* **6**: No. 2, 201-205(1977).

Effect of cadmium chloride on dry weights accumulation, height growth, nd relative conductivity of stems of silver maple (Acer saccharinum L.) seedlings exposed to 0, 5, 10, or 20 ppM $CdCl_2$. $2\frac{1}{2}$ H_2O (on weight basis of rooting media) was determined. Leaf, stem, and root dry weight were significantly reduced by all $CdCl_2$ treatments. Seedling height at 8 weeks was severely reduced and strongly corrlated with applied $CdCl_2$ levels. Relative conductivity of excised stem sections was significantly reduced by Cd treatment. The reduction was caused by (i) a progressive decrease in the proportion of xylem tissue available for water conduction, (ii) reduced size of vessels and tracheids, and (iii) partial blockage of xylem elements by cellular debris or gums. These findings are discussed in relation to water stress.

38270 Effect of redox potential and pH on the uptake of cadmium and lead by rice plants. Reddy, C.N.; Patrick, W.H. Jr. (Louisiana State Univ., Baton Rouge). *J. Environ. Qual.;* **6**: No. 3, 259-262(1977).

Redox potential and pH are two of the major factors influencing the mobilization and immobilization of heavy metals in flooded soils and sediments, and their availability to plants. A system developed for growing plants in soil suspensions where redox potential and pH can be controlled was used to study the uptake of cadmium (CD) and (lead (Pb) by rice plants (Oryza sativa L.). Uptake of Cd and Pb by root and shoot tissue, and their translocation from root to shoot, was determined at six different redox potentials (-200, -100, 0, +200, and +400 mV) and four pH values (5, 6, 7, and 8). The effects of redox potential and pH on the levels of water-soluble Cd and Pb in the soil suspensions were also studied. Almost all Cd entering the rice plants accumulated in the shoots. Total Cd uptake and shoot uptake increased with an increase in suspension redox potential and a decrease in pH. Water-soluble Cd in the soil suspension was significantly correlated with total plant Cd and Cd uptake by shoot. Total Pb uptake, including Pb associatd with the roots, decreased with an increase in suspension redox potential and pH. Uptake of Pb by shoot decreased with an increase in pH. No definite redox potential effect was found on Pb uptake by the shoot. Lead was less mobile than Cd in the rice plants and was primarily associated with the roots. Water-soluble Pb decreased with an increase in redox potential and pH, and was significantly correlated with total plant Pb uptake and Pb uptake by shoot.

38271 (ORNL-tr—4601) **Trace elements from fossil fuels as a cause of damage to vegetation.** Bortitz, S. Translated by S.D. Blalock Jr. from *Freiberg. Forschungsh., C;* **3**: No. 317, 149-157(1976). 7p. Dep. NTIS, PC A02/MF A01.

The effects of emissions from brown-coal fired power plants on vegetation are discussed. Besides the known effects of SO_2 which directly inhibit the assimilation organs of plants, fluorine compounds and sulfides are of particular interest because of the alkaline reaction of dusts and other trace elements like boron or arsenic which sometimes influence plant growth above ground or get into the food chain by settling on the plants. Efforts should be aimed not only at determining the total dust quantity for which maximum permissible values have been set, but increasing attention should be given the qualitative composition of dust sediments or the determination of quantities of individual trace elements in order to be able to recognize and possibly reduce phytotoxic effects, changes in soil, and harmful effects on the food chain in time.

38272 Studies on planting trees in a smoke-polluted area. On the actual state of damage of trees due to air pollution in Iwaki area.

Fukushima-Ken Ringyo Shikenjo Hokoku; No. 6, 38-39(Dec 1974). (In Japanese).

Damage to trees in the Iwaki area, ranging from slight growth suppression to changes in leaf color, leaf-fall, and withering, was examined in relation to industrial sulfur oxide emissions. A survey of local conditions, amount of tree growth, index of damage, and the sulfur content of leaves from each of 20 pine trees (Pinus densiflora) 10 to 20 yr old was performed. There was a positive logarithmic relationship between the elongation of new twigs and the distance from the smoke source. Generally, the vigor of trees was higher, the greater the distance from the smoke source, with some exceptions suggesting the effect of topography. Sulfur content showed the same inverse tendency with some exceptions, and it was lower than that determined previously. The sulfur content of leaves of Quercus serrata was one and a half to two times greater than that of P. densiflora.

INVERTEBRATES

REFER ALSO TO CITATION(S) 38071, 38082, 38133, 38261, 38264, 38289

38273 Relationship of scarlet prawns (Plesiopenaeus edwardsianus) to a benthic oil deposit off the north-west coast of Aruba, Dutch West Indies. Thompson, H.C. Jr.; Farragut, R.N.; Thompson, M.H. (National Marine Fisheries Service, Miami, FL). *Environ. Pollut. (London);* **13**: No. 4, 239-253(Aug 1977).

Catch data resulting from sampling efforts off the north-west coast of Aruba, Dutch West Indies, demonstrated a greater catch rate of crustacea in areas where benthic oily material was collected as compared to adjacent areas where there was no oil. Scarlet prawns (Plesiopenaeus edwardsianus) were three times more abundant in the areas where benthic oil was found. They contained no isoprenoid hydrocarbons of the type common to most biological material or the type common to petroleum. However, they did contain an unusual n-paraffin hydrocarbon series (n-C_{22}, n-C_{25}, n-C_{28}, n-C_{31}, n-C_{34}), and in the areas where the benthic oily material was collected the prawns contained much greater quantities of the five n-paraffins given in the above sequence. A probable explanation for the greater abundance of crustacea in the area affected by the oily material is discussed. The accumulation and metabolism of hydrocarbons by marine organisms and how these processes relate to scarlet prawns are also discussed.

38274 Responses of th clam Macoma balthica to Prudhoe Bay crude oil. Shaw, D.G.; Paul, A.J.; Smith, E.R. (Inst. of Marine Science, Fairbanks, Alaska). pp 493-494 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

The responses of the bivalve mollusk Macoma balthica to crude oil have been studied under laboratory conditions designed to simulate the stranding of oil on intertidal sediments in which this animal resides. The relationship of dry tissue weight to shell length, an indirect indicator of general health and fitness, was not significantly altered by exposure to oil at a level which did result in significant mortalities. This suggests that death is caused by a metabolically specific mode of poisoning rather than by a general weakening of the animal. In a second experiment, animals were subjected to two temporarily separated oiling events. Neither in mortalities nor in gas chromatographic analysis of tissues for hydrocarbons were cumulative effects observed. It was also found that a previously-reported tendency of M. balthica to burrow to the sediment surface in the presence of oil increases with decreasing depth of available sediment. We suggest that this behavior may be used as a convenient indicator of oil pollution.

38275 Sublethal effects of natural chronic exposure to petroleum on marine invertebrates. Straughan, D. (Univ. of Southern California, Los Angeles). pp 563-568 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

Comparative field studies were conducted in an area of natural chronic exposure to petroleum (Coal Oil Point) and at control sites between 1972 and 1974. Studies of the larger (mesh 2 mm) benthic infaunal invertebrates in shallow water (20-35 m) revealed organisms living in sediments with total CCl_4 extractables higher than 10,000 mg/l at Coal Oil Point. These sediments contained petroleum hydrocarbons. The total CCl_4 extractables in sediments from control sites which did not contain petroleum hydrocarbons were generally less than 100 mg/l. Petroleum hydrocarbons were recorded in tissues of abalone, mussels, and stalked barnacles from Coal Oil Point, although it is notable that all detected petroleum hydrocarbons were in the viscera and not in the foot of abalone. Data obtained in these studies did not reveal a significant change in reproduction, growth, or distribution that could be related to presence of petroleum in the tissues. However, there was a decrease in reproduction in stalked barnacles due to a "black body" effect of surrounding tar. There was no evidence of malformations in organisms living in the area of natural chronic exposure to petroleum. Petroleum hydrocarbons levels were higher in sediment and mussel tissues from Coal Oil Point than from the area around two producing oil rigs in the Santa Barbara Channel.

38276 Effects of crude oil on larvae of lobster Homarus americanus. Forns, J.M. (Westinghouse Ocean Research Lab., Annapolis). pp 569-573 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

The effects of API reference South Louisiana crude oil upon four larval stages of American lobster (Homarus americanus) were determined in a flow-through system. Tests were conducted with naturally-hatched animals in individual test chambers as well as in mass culture systems in an operating state lobster hatchery. Experimental flow-through crude oil exposure concentrations were 0.1, and 1.0 ppM, administered as a strongly-agitated emulsion-like mix to ambient temperature seawater ranging from 15°-20°C. Oil exposure residence times ranged from 0.8-5.6 minutes depending on the test. Exposed animals were monitored six times daily for feeding behavioral characteristics, mobility, molting success, growth and development times to reach the fourth larval stage. Pigmentation analysis was performed on individual larvae by photomicroscopy, and hydrocarbon analyses were also conducted thereon. Post-larval development through the eighth stage was investigated. Statistical comparisons were made among different control animals and between control and oil-exposed larvae.

38277 Sensitivity of larval and adult Alaskan shrimp and crabs to acute exposures of the water-soluble fraction of Cook Inlet crude oil. Brodersen, C.C.; Rice, S.D.; Short, J.W.; Mecklenburg, T.A.; Karinen, J.F. (National Marine Fisheries Service, Auke Bay, AK). pp 575-578 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

The sensitivity of adult and larval Alaskan shrimp and crabs to the water-soluble fraction (WSF) of Cook Inlet crude oil was measured by tests using 96-hour static bioassays at the water temperatures that these animals normally encounter. Larval crustaceans were found to die more slowly than adults, making it necessary to measure sensitivity in terms of concentrations causing moribundity (death imminent) instead of in terms of concentrations causing death during exposure. The cessation of all motion and reaction was found to indicate moribundity in adults, and the cessation of swimming was found to indicate morbundity in larvae exposed for 96 hr. Ninety-six-hour LC_{50}'s for moribundity for stage I larvae ranged from 0.95 to 1.8 ppM depending on species, while 96-hr LC_{50}'s for adults ranged from 1.9 to 4.2 ppM oil. Sensitivities for stage I-VI larvae of coonstripe shrimp ranged between 0.24 ppM and 1.9 ppM. Larvae were more sensitive to oil than adults. The sensitivity of larvae depended on species and developmental stage. Larvae are probably more vulnerable than adults to oil exposure because of greater sensitivity to oil and greater susceptibility to predation. Cold-water species may be particularly vulnerable because of increased time spent as developing larvae.

38278 Bioavailability of petroleum hydrocarbons from water, sediments, and detritus to the marine annelid, Neanthes arenaceodentata. Rossi, S.S. (Scripps Institution of Oceanography, La Jolla, CA). pp 621-625 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

Uptake, retention, metabolism, and depuration of diaromatic hydrocarbons by the polychaete, Neanthes arenaceodentata, were examined in experiments utilizing seawater solutions and sediments contaminated with either No. 2 fuel oil water-soluble fractions or radio-labelled naphthalenes. Polychaetes rapidly accumulate $_{14}$C-naphthalene (magnification factor = 40X) from solution during short-term exposure (24 hr). Worms slowly released hydrocarbons accumulated during acute exposure down to undetectable levels (less than 0.05 ppM) within 300 hours after return to clean seawater. $_{14}$C-

naphthalene accumulated from solution was metabolized by polychaetes, and associated microflora apparently play no role in uptake, release, or metabolism. Analyses of worms held for 28 days in clay-silt sediments artificially contaminated with No. 2 fuel oil (8 μg total naphthalenes/g wet sediment) indicate that naphthalenes were not accumulated by worms at tissue concentrations above 0.1 ppM. Polychaetes likewise failed to accumulate $_{14}$C-methylnaphthalene from ingestion of contaminated detritus (10 to 15 μg $_{14}$C-methylnaphthalene/g dry detritus) for 16 consecutive days. These data suggest that petroleum hydrocarbons bound to sediment particles or particulate organic matter are less available to marine worms than those in solution.

38279 Petroleum sulfur-containing compounds and aromatic hydrocarbons in the marine mollusks Modiolus demissus and Crassotrea virginica. Lake, J.L.; Hershner, C. (Virginia Inst. of Marine Science, Gloucester Point). pp 627-632 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

The in situ recovery of the mussel Modiolus demissus and the oyster Crassostrea virginica from successive small experimental dosings of No. 2 fuel oil was examined to determine the retention and release of petroleum hydrocarbons and petro-sulfur compounds from these marine mollusks. Extracts were obtained from the organisms over a four-month recovery period, and were analyzed by flame ionization detection (FID) and flame photometric detection (FPD) gas chromatography, and gas chromatography-mass spectrometry (GCMS). Results showed a large majority of the petroleum compounds that were present in these organisms after two weeks of recovery were lost by the 15th week. Both mollusks showed an enrichment of aromatic (relative to saturated) hydrocarbons during the first portion of recovery. As the recovery time lengthened, the aromatics were lost more rapidly than the saturates. Mussels showed relative increases in some individual aromatic hydrocarbons during the recovery period. The oysters, however, appeared to non-selectivity depurate the aromatic hydrocarbons. The higher molecular weight petro-sulfur compounds were retained for the longest time periods. During the study period these compounds appeared to be lost from the mollusks at rates similar to those observed for the aromatic hydrocarbons.

38280 Uptake of naphthalenes by the clam, Rangia cuneata, in the vicinity of an oil separator platform in Trinity Bay, Texas. Fucik, K.W.; Armstrong, H.W.; Neff, J.M. (Texas A and M Univ., College Station). pp 637-640 of Proceedings of the 1977 oil spill conference (prevention, behavior, control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

In three separate experiments, the clam, Rangia cuneata was exposed under and near an oil separator platform in Trinity Bay, Texas for periods of approximately 100 days. The greatest naphthalenes uptake was in those clams exposed beneath the platform. Clams exposed at distances of 150-1,000 m from the platform showed little or no uptake of naphthalenes. In clams returned to the lab and allowed to depurate, most of the accumulated naphthalenes were released although detectable levels remained in some of the clams after 47 days. There was good correlation between the rates of naphthalenes uptake by the clams and naphthalenes levels in the sediments at the different stations. However, clams analyzed by gas chromatographic techniques showed high levels of weathered hydrocarbons suggesting that the sediments are a source of hydrocarbons accumulated by the clams. The results are discussed in relation to the physical features of Trinity Bay which is a very shallow, semi-enclosed body of water with a high suspended sediment load.

38281 Effects of mercury on the behavior and oxygen consumption of Monodonta articulata. Saliba, L.J.; Vella, M.G. (Univ. of Malta, Msida). *Mar. Biol.;* **43**: No. 3, 277-282(1977).

The trochid snail Monodonta articulata Lamarck was exposed to mercuric sulphate at concentrations of 0.2, 0.5, 0.8 and 1 ppM Hg^{++}. At 24 h, retraction into the shell was observed in 0.8 and 1 ppM Hg^{++}; this retraction increased in these concentrations at 36 h. Retracted snails died if retained in the solutions, but generally recovered within 24 to 48 h if transferred to uncontaminated seawater. Immersion-emersion behavior and interface activity were studied over 24 h by means of an aktograph; snails in normal seawater spent more time below than above the water surface, and exhibited frequent periods of activity. Exposure to mercuric sulphate at concentration of 0.25, 0.5, 0.8 and 1 ppM Hg^{++} progressively reduced both the length and frequency of activity periods. From 0.5 ppM Hg^{++} upwards, emersion periods increased, and immersion periods decreased. Oxygen consumption of snails was measured in seawater and in mercuric sulphate at concentrations of 0.2, 0.5, 0.8 and 1 ppM Hg^{++}. Oxygen consumption decreased significantly with each progressive rise in mercury concentration. It is considered that mercury affects M. articulata by interfering with respiration, initially reducing interface activity, then forcing the snail for longer and longer periods out of the water. Retraction occurs when activity is no longer possible. It is concluded that respiratory and behavioral alterations of this nature would afford a good indicator of the presence of sub-lethal concentrations of pollutants.

38282 Toxicity evaluation of a complex metal mixture to the softshell clam Mya arenaria. Eisler, R. (Environmental Protection Agency, Narragansett, RI). *Mar. Biol.;* **43**: No. 3, 265-276(1977).

Adults of the soft-shell clam Mya arenaria were continuously subjected to a flowing raw seawater solution containing a mixture of salts of manganese, zinc, lead, nickel, copper, and cadmium. Final calculated concentrations, in $\mu g\ l^{-1}$, of the toxicant solution were 7200 Mn, 2500 Zn, 70 Pb, 50 Ni, 50 Cu and 1 Cd; these concentrations approximated highest measured levels within surficial interstitial sediment waters from mid-Narragansett Bay, Rhode Island. M. arenaria were also subjected to a 20% solution. One study was conducted for 112 days in winter at 0° to 10°C and another for 16 days in summer at 16° to 22°C. In the winter study, all clams exposed to a 100% solution died between the 4th and 10th week; soft parts of survivors at 6 weeks contained about 19 times more Pb, 15 x more Zn, 12 x more Cu, 10 x more Mn, 3 x more Ni and 0.1 x more Cd than controls. Clams exposed to a 20% soution during winter survived the 112 day study; at that time these contained about 5 x more Cu, 4 x more Mn, 3 x more Zn and about 2 x more Pb than controls. In the summer study, all M. arenaria subjected to th 100% solution died between 6 and 14 days; survivors from this group at 7 days contained about 25 x more Pb, 13 x more Cu, 11 x more Zn, 7 x more Mn, and 3 x more Ni than controls. Mortality in the 20% group during summer was slightly higher than controls during the 16 day study; at 14 days survivors from this group contained about 12 x more Mn, 7 x more Pb, 7 x more Zn, 4 x more Cu, and 3 x more Ni than conttrols. Survival and bioaccumulation patterns were not altered through feeding a supplemental diet of algae.

38283 Common mussel Mytilus edulis as an indicator of trace metals in Scandinavian waters. I. Zinc and cadmium. Phillips, D.J.H. (Uppsala Univ.). *Mar. Biol.;* **43**: No. 4, 283-291(1977).

Concentrations of zinc and cadmium in whole soft parts of mussels, Mytilus edulis (L.), collected from 54 locations in Scandiavian waters were determined. Local variations in concentrations of the two metals found in samples taken close to industrial sources of zinc and cadmium confirmed the ability of the mussel to act as an accurate indicator of pollution by these metals over the entire range of salinities in which this species can exist. In addition, offshore samples remote from industrial discharges revealed higher concentrations of zinc and cadmium in mussels from low-salinity areas (Gulf of Finland, Southern Bothnian Sea, Baltic proper) than in those from high-salinity areas (Kattegat, Eastern Skagerrak). Major decreases in metal concentrations present in the mussel were apparent in the regions of the Sound and the Great Belt, which are areas of rapid salinity change due to mixing of Baltic water with water from Kattegat. Comparison of these results with those reported for zinc and cadmium in water throughout the study area suggested the existence of a higher biological availability of these metals in regions of low salinity; possible reasons for this are discussed. Data from the present survey are also compared to those reported for mussels taken elsewhere. This comparison reveals the Baltic area to be considerably polluted by trace metals; in contrast, the waters of Kattegat and Skagerrak are considered to be relatively unpolluted.

38284 Mercury stress on juvenile bay scallops, Argopecten irradians, under various salinity-temperature regimes. Nelson, D.A.; Calabrese, A.; MacInnes, J.R. (National Marine Fisheries Service, Milford, CT). *Mar. Biol.;* **43**: No. 4, 293-297(1977).

Survival of juvenile bay scallops, Argopecten irradians, after 96 h of exposure to mercury at various salinity and temperature regimes was studied. Scallop survival was significantly affected by mercury concentration and by salinity, as well as by the interaction between temperature and concentration and between temperatures and salinity. Toxicity of mercury at low concentrations was enhanced by high temperature and low salinity, whereas at high mercury concentrations this effect diminished.

38285 Survival and growth of bivalve larvae under heavy-metal stress. Calabrese, A.; MacInnes, J.R.; Nelson, D.A.; Miller, J.E. (Milford Lab., CT). *Mar. Biol.;* **41**: No. 2, 179-184(1977).

In a study of the toxicity of mercury, silver, copper, nickel, and zinc to larvae of the American oyster Crassostrea virginica and hard clam Mercenaria mercenaria, the concentrations at which 5% (LC_5), 50% (LC_{50}), and 95% (LC_{95}) of the larvae died were determined, as well as growth at the LC_5 and LC_{50} values. The order of toxicity for oyster larvae was Hg > Ag > Cu > Ni, and for clam larvae Hg > Cu > Ag > Zn > Ni. Growth of larvae of both species, with the exception of clam larvae in nickel-treated water,

was not reduced at the LC_5 values, but was markedly reduced at the LC_{50} values.

VERTEBRATES

REFER ALSO TO CITATION(S) 37952, 37953, 38071, 38082, 38222, 38240, 38298, 38299

38286 (LA—7206-MS) **Preliminary toxicological study of bis-dinitro-propyl-formal:bis-dinitro-propyl-acetal.** Smith, D.M.; Drake, G.A.; London, J.E.; Wilson, J.S.; Holland, L.M.; Thomas, R.G. (Los Alamos Scientific Lab., N.Mex. (USA)). Mar 1978. Contract W-7405-ENG-36. 7p. Dep. NTIS, PC A02/MF A01.

Bis-dinitro-propyl-formal:bis-dinitro-propyl-acetal (BDNPF:BDNPA) is used for industrial purposes primarily as a nitroplasticizer. The acute toxicity, primary skin irritation reaction, skin sensitivity reaction, eye irritation response, and dominant lethal assay index for this eutectic mixture are reported for rabbits, mice, and guinea pigs.

38287 (LA—7207-MS) **Preliminary toxicological study of kerimide 601 resin.** Smith, D.M.; Drake, G.A.; London, J.E.; Wilson, J.S.; Holland, L.M.; Thomas, R.G. (Los Alamos Scientific Lab., N.Mex. (USA)). Mar 1978. Contract W-7405-ENG-36. 5p. Dep. NTIS, PC A02/MF A01.

The acute oral LD_{50} values for kerimide 601 resin for mice and rats is greater than 5 g/kg. According to classical guidelines, the mixture would be considered slightly or practically nontoxic in both species. Skin application studies in the rabbit with kerimide 601 resin demonstrated that it was cutaneously nonirritating. This resin was also nonirritating in rabbit eye application studies. The sensitization study in the guinea pig did not show resin to be deleterious in this regard, although delayed necrosis was seen at the injection sites 96 h after administration.

38288 Health effects of short-term inhalation of nitrogen dioxide and ozone mixtures. Ehrlich, R. (IIT Research Inst., Chicago); Findlay, J.C.; Fenters, J.D.; Gardner, D.E. *Environ. Res.;* **14**: No. 2, 223-231(Oct 1977).

The effects of single and multiple daily 3-hour exposures to nitrogen dioxide (NO_2) and ozone (O_3) mixtures on the resistance to steptococcal pneumonia were investigated. The concentrations of NO_2 ranged from 1.5 to 5.0 ppM, and those of O_3, from 0.05 to 0.5 ppM. The effect of a single exposure to the mixture was additive, whereby the excess mortality rates were equivalent to those induced by the inhalation of each individual pollutant. The ability to clear inhaled bacteria from the lungs was diminished in mice exposed to the NO_2-O_3 mixtures for 3 hours. This impairment was manifested by the increased frequency of isolation of Streptococcus from the lungs for up to 6 days after the respiratory challenge. Excess mortalities observed after 20 daily 3-hour exposures suggested that a synergistic effect might be present upon repeated inhalation of pollutant mixtures, that made them more effective in reducing resistance to respiratory infection. The results emphasize the need for the establishment of primary air quality standards for short-term NO_2 exposures.

38289 Mirex: an overview. Waters, E.M.; Huff, J.E.; Gerstner, H.B. (Oak Ridge National Lab., TN). *Environ. Res.;* **14**: No. 2, 212-222(Oct 1977).

Mirex, a chlorinated insecticide, is the active ingredient in bait used to control the imported fire ant. Prepared in 1946, mirex was first introduced for use in pesticidal formulations in 1959; mirex acts as a stomach poison. Extreme persistence in the natural environment provides an opportunity for accumulation of the food chain. No metabolism of mirex appears to take place in mammalian systems, although mirex causes liver damage and has been reported to produce hepatomas in mice. Mirex readily crosses the rat placental barrier; while no teratogenic effects are apparent, reduced litter size and a high incidence of cataracts in the offspring have been reported. An abstracted literature collection spanning the years 1947 to 1976 of 325 references has been published by Waters and Black (1976).

38290 Effect of carbon monoxide exposure on blood fibrinolytic activity in rabbits. Kalmaz, E.V.; Canter, L.W.; Nau, C.A.; Hampton, J.W. (Oklahoma Medical Research Foundation, Oklahoma City). *Environ. Res.;* **14**: No. 2, 194-202(Oct 1977).

One of two groups of rabbits were exposed to carbon monoxide (CO, 50 ppM by volume) for 24 hr continuously for 8 weeks, whereas the second breathed ambient air. Percentage oxyhemoglobin (HbO_2), percentage hemoglobin (g/100 ml), and percentage carboxyhemoglobin (COHb) were monitored in both groups. The mean percentage carboxyhemoglobin increased up to 30.91% at the end of the eighth week. Tests of fibrinolysis were monitored and showed acceleration of the whole-blood clot lysis, euglobulin lysis, and increase in whole-blood clotting time. A fibrin plate test confirmed the increased lysis, and serum fibrin/fibrinogen degradation products were elevated in the CO-exposed animals. No changes were observed in the same tests in the rabbits exposed to ambient air.

38291 Polynuclear aromatic hydrocarbons in marine tissues. Pancirov, R.J.; Brown, R.A. (Exxon Research and Engineering Co., Linden, NJ). *Environ. Sci. Technol.;* **11**: No. 10, 989-992(Oct 1977).

Shell and fin fish contain benzo(a)pyrene and other polynuclear aromatic hydrocarbons at the parts per billion level or below. The presence of pyrene at a much higher relative concentration than its methyl isomers indicates the hydrocarbons are from a combustion source.

38292 Reduced mercury excretion with feces in germfree mice after oral administration of methyl mercury chloride. Nakamura, I.; Hosokawa, K.; Tamura, H.; Miura, T. (Teikyo Univ. School of Medicine, Tokyo). *Bull. Environ. Contam. Toxicol.;* **17**: No. 5, 528-533(May 1977).

When methyl mercury chloride was administered orally the amount of mercury excretion with feces of germfree mice was noticeably lower than that of the control mice. Germfree mice excreted 24 percent of the administered mercury within 10 days of administration while the control mice excreted 46 percent. Mercury retention in the organs of germfree mice was slightly higher than in the control mice. These results suggest that the existence of microorganisms in animal intestines are concerned with mercury excretion in the animal body.

38293 Effects of dietary and inhalative cadmium on hemoglobin and hematocrit in rats. Prigge, E.; Baumert, H.P.; Muhle, H. (Institut fuer Aerobiologie, Grafschaft, Ger.). *Bull. Environ. Contam. Toxicol.;* **17**: No. 5, 585-589(May 1977).

Th dfference of the effects of dietary and inhalative cadmium on hemoglobin and hematocrit was investigated using Wistar male rats. For the inhalation studies, rats were exposed to $CdCl_2$ aerosols (0.2 mg Cd/m^3) for 66 days. For the dietary experiments the rats received 25, 50 and 100 ppM cadmium as $CdCl_2$ in drinking water. The following parameters were measured: the body weights of the animals, hematocrit and hemoglobin in blood, and the Cd content of liver and kidney. The results showed a retardation of growth in the aerosol-exposed group and the group with 100 ppM oral Cd intake. The relation of the Cd content of kidney to liver averaged 1.7 for the oral-exposed groups and 4.4 for the inhalation-exposed groups. The hematocrit and hemoglobin values for the inhalation-exposed rats showed no significant differences when compared to the controls, but the values for the dietary cadmium group showed a significant reduction.

38294 Mercury accumulation by largemouth bass (Micropterus salmoides) in recently impounded reservoirs. Abernathy, A.R. (Clemson Univ., SC); Cumbie, P.M. *Bull. Environ. Contam. Toxicol.;* **17**: No. 5, 595-602(May 1977).

Mercury levels of largemouth bass from three reservoirs in the southeastern United States were highest in the younger, relatively oligotrophic reservoirs and were significantly lower in an older, more eutrophic reservoir in the same drainage system. The reservoir with the highest mercury levels in bass is the reservoir farthest upstream and is not subject to inputs of municipal or industrial wastes. The source of mercury in these reservoirs appears to be the soil which formed their original sediments. Preliminary data indicate that mercury levels in largemouth bass in these systems decline as the reservoirs age. Elevated mercury levels in fish appear to be a transitory phenomenon in newly impounded, relatively oligotrophic reservoirs.

38295 Induction of hepatic aryl hydrocarbon hydroxylase in salmon exposed to petroleum dissolved in seawater and to petroleum and polychlorinated biphenyls, separate and together, in food. Gruger, E.H. Jr.; Wekell, M.M.; Numoto, P.T.; Craddock, D.R. (National Marine Fisheries Service, Seattle). *Bull. Environ. Contam. Toxicol.;* **17**: No. 5, 512-519(May 1977).

Hepatic Aryl hydrocarbon hydroxylase (AHH) is induced in coho salmon exposed to 1 ppM PCB's in the diet; however, comparable experiments with 1 ppM of Prudhoe Bay crude oil did not significantly alter the AHH activities. These findings suggest that in aquatic food-chains containing both petroleum hydrocarbons and PCB's, the latter compounds may exert a predominant influence on the induction of the hepatic AHH enzyme system. Young coho salmon exposed to 150 ppB (0.15 ppM) of a seawater-soluble fraction of Prudhoe Bay crude oil for 6 days exhibited a significant induction of hepatic AHH. Thus, crude oil components of relatively high water solubility (e.g., methylated naphthalenes and polyalkylated benzenes) may be more effective than high molecular weight insoluble components in inducing AHH.

38296 Distribution of naphthalenes within exposed Fundulus similus and correlations with stress behavior. Dixit, D. (Northern Virginia Community Coll., Sterling); Anderson, J.W. pp 633-636 of Proceedings of the 1977 oil spill conference (prevention, behavior,

control, cleanup). Ludwigson, J.O. (ed.). Washington, DC; American Petroleum Institute (1977).

From Oil spill conference; New Orleans, LA, USA (8 Mar 1977).

See CONF-770325—.

Fundulus similus was exposed to naphthalene via oral administration, and naphthalene plus alkylnaphthalenes in water. The distribution of these compounds within the organs and tissues of the fish was monitored with time. Turn-over times for these compounds were relatively rapid, particularly in the case of naphthalene administered orally. Accumulation within detoxification (liver) and storage (gall bladder) was expected, but accumulation and retention in the brain were higher than anticipated. Stress-produced behavioral abnormalities may correspond to the content of naphthalenes in the brain and other tissues of the nervous system.

38297 Effects of low levels of dietary cadmium in animals: a review. Doyle, J.J. (Veterinary Toxicology and Entomology Research Lab., College Station, TX). *J. Environ. Qual.;* **6**: No. 2, 111-116(1977).

Cadmium is a toxic metal commonly found in small quantities in animal and human foods. The possible effects on domestic animal and human health from exposure over long periods to low (0 to 10 ppM) dietary concentrations of the metal is currently a cause for concern. Experimental data from laboratory animals indicate that low dietary concentrations of the metal will impair growth, cause hypertension and sodium retention, and produce adverse effects on some enzyme systems, reproduction and tissue levels of some essential metals. Some of these toxic effects may be prevented by supplementary levels of iron, copper, zinc, selenium, and manganese in the diet.

MAN

REFER ALSO TO CITATION(S) 37959, 37960, 37961, 37962, 38297

38298 (ORNL/TIRC—77/3) **Vinylidene chloride. I. An overview. II. A literature collection, 1947 to 1977.** Warren, H.S.; Ricci, B.E. (Toxicology Information Response Center, Oak Ridge, Tenn. (USA)). Apr 1978. Contract W-7405-ENG-26. 55p. NTIS, PC E08/MF E08.

Fifty-four abstracts of papers that discuss the physical properties, chemical reactions, and toxicity of vinylidene chloride (VDC) are presented. An overview summarizes data on the effects of acute and chronic exposures of rats by inhalation or ingestion, mutagenicity in Salmonella typhimurium, and skin and eye irritation and neurological symptoms in man following exposures to VDC. Hazards from explosions when VDC is handled or stored in the presence of air are pointed out.

38299 (ORNL/TIRC—78/2) **Polychlorinated biphenyls, polybrominated biphenyls, and their contaminants: a literature compilation, 1965—1977.** Winslow, S.G.; Gerstner, H.B. (Toxicology Information Response Center, Oak Ridge, Tenn. (USA)). Mar 1978. Contract W-7405-ENG-26. 378p. NTIS, PC E13/MF A01.

Biphenyl compounds have been used in various industrial applications. Because of chemical stability and resistance to thermal decomposition, they are ideally suited as heat-transfer fluids--one of their main applications. Biphenyl compounds have also been used as dye carriers for plastics and synthetic fibers and, to a lesser degree, as coatings for citrus fruit wrappers because of their mild fungicidal properties. Aside from extensive use in the electrical industry, polychlorinated derivatives (PCBs) also appear in certain pesticidal formulations. Polybrominated biphenyls (PBBs) have found widespread applications as fire retardants. During the manufacture of PCBs, several side products occur; among these are dibenzofurans and chlorinated naphthalenes. Although small in quantity, these contaminants are of concern because of their toxic potential. This bibliography is divided into four individual sections: Polychlorinated Biphenyls (PCBs); Polybrominated Biphenyls (PBBs); Dibenzofurans; and Chlorinated Naphthalenes. Each section has its own permuted title index for easy access to the literature references. Nomenclature used for searching the computer files and numbers of references retrieved are listed separately for each section.

38300 Prevalence of lead disease among secondary lead smelter workers and biological indicators of lead exposure. Lilis, R. (City Univ. of New York); Fischbein, A.; Eisinger, J. *Environ. Res.;* **14**: No. 2, 255-285(Oct 1977).

The report concerns itself primarily with the assessment of medical and biochemical effects of chronic lead exposure and comparing the usefulness of various biological screening parameters. In addition it appraises the effects of chelation therapy to control blood lead levels in lead workers, which have recently attracted critical attention. It is of considerable importance to ascertain whether such a therapeutic approach may, under some circumstances, in fact contribute to the deleterious effects of undue lead exposure.

OTHER ENVIRONMENTAL POLLUTANT EFFECTS

38301 Colony size and giant cell formation from mammalian cells exposed to 1 MHz ultrasound. Miller, M.W.; Ciaravino, V.; Kaufman, G.E. (Univ. of Rochester, NY). *Radiat. Res.;* **71**: No. 3, 628-634(Sep 1977).

Chinese hamster ovary (CHO) cells were exposed to continuous wave 1 MHz, 5 W/cm^2 ultrasound for 5 min, plated, and allowed to grow for 7 days; colonies were then scored for size and for the presence of giant cells. Sonicated colonies contained fewer cells than controls by a factor 0.53 ($P < 0.001$), but contained more giant cells than sham controls by a factor of 1.30 ($P < 0.001$). On a per cell basis the frequency of giant cells was 2.47 times higher in the colonies arising from sonicated cells. Characteristics of giant cells varied; all were abnormally large cells with one large nucleus or several smaller nuclei and/or protoplasmic bridges.

HEALTH AND SAFETY

38302 Radiological safety by design. 2. N.R.P.B. viewpoint. Harrison, N.T. (National Radiological Protection Board, Glasgow (UK). Scottish Centre). *Ann. Occup. Hyg.;* **20**: No. 3, 313-316(Dec 1977).

Consideration is given to the role of the National Radiological Protection Board in relation to radiological safety by design. The recommendations of the International Commission on Radiological Protection are discussed and a description is given of a general and consecutive procedure of justification, optimisation and comparison with recommended dose limits which can be applied to any industrial and other uses of ionising radiations.

38303 USERDA transport R and D program for environment and safety. Sisler, J.A. (Energy Research and Development Administration, Washington, D.C. (USA). Div. of Waste Management and Transportation). pp 103-108 of Transport packaging for radioactive materials. Vienna; IAEA (1976).

From Symposium on the design, construction and testing of packaging for the safe transport of radioactive materials; Vienna, Austria (23 Aug 1976).

See CONF-760813—.

This paper describes the U.S. Energy Research and Development Administration's (ERDA) transportation environment and safety research and development program for energy fuels and wastes, including background, current activities, and future plans. It will serve as an overview and integrating factor for the several related technical papers to be presented at this meeting which will enlarge on the detail of specific projects. The transportation R and D program provides for the environmental and safety review of transport systems and procedures; standards development; and package, vehicle, and systems testing for nuclear materials transport. A primary output of the program is the collection, processing, and dissemination of transport environment and safety data, shipment statistics, and technical information. Special transport projects which do not easily fit elsewhere in ERDA are usually done as a part of this program.

GEOSCIENCES

REFER ALSO TO CITATION(S) 36717

GEOLOGY AND HYDROLOGY

REFER ALSO TO CITATION(S) 38062

38304 (CONF-7504139—) **Engineering geology and soils engineering symposium.** (Idaho Transportation Dept., Boise (USA). Div. of Highways; Idaho Univ., Moscow (USA); Idaho State Univ., Pocatello (USA); Boise State Univ., Idaho (USA)). 1975. 304p. Geology and Soils Engineering Symposium, Boise, ID.

From 13. engineering geology and soils engineering symposium; Moscow, ID, USA (2 Apr 1975).

Twenty-two papers were presented. Four have been abstracted and indexed individually for EDB/ERA. (JGB)

38305 P/sub n/ velocity and partial melting: discussion. Chung, D.H. (Univ. of California, Livermore). *Tectonophysics;* **42**: No. 1, T35-T42(28 Sep 1977).

The seismologically observed P/sub n/ velocity anomalies in the conterminous United States are restricted to the lithosphere, but the observed teleseismic delay-time variations are due principally to the regional variations in the physical state (i.e., thickness of low-velocity zone and/or percent melt, etc.) of the asthenosphere. The observed low P/sub n/ velocity has been attributed to partial melting in the upper mantle, but it is shown that the partial-melting model alone cannot explain the seismologically observed P/sub n/ velocities in such an anomalous region as the Basin and Range Province. The present structure of the basin and Range Province is possibly a result of rifting in the western conterminous United States; under it there may lie a mixed structure of old crust and mantle materials. The low-velocity zone under the Basin and Range Province would then be caused by downward chemical transition from the sub-Moho pyrolitic mantle material into a plagioclase-rich ophiolitic (old oceanic crust and upper mantle) composition and associated melting, and then into a peridotitic composition at the bottom of the low-velocity zone. This mixed material model, with partial melting, would explain the low P/sub n/ velocity and low seismic Q in the region, as well as other geophysical observations.

GEOPHYSICS

38306 (USGS—474-239) **Report of exploration progress, Pahute Mesa, October 1, 1969—December 31, 1976.** Orkild, P.P.; Jenkins, E.C. (Geological Survey, Denver, Colo. (USA)). Mar 1978. Contract EY-76-A-08-0474. 114p. Dep. NTIS, PC A06/MF A01.

Lithologic logs for 80 exploratory, emplacement, and proposed drill holes on Pahute Mesa, Nevada Test Site, show that the rocks penetrated are Miocene age or younger. The deepest hole drilled, UE20f, bottomed at 13,686 feet (4,171 m) in pre-Silent Canyon rocks. Locations of drill holes are included.

SEISMOLOGY AND TECTONICS

38307 (CONF-7504139—, pp 33-49) **Refraction data enhancement techniques.** Johnson, W.E. 1975.

From 13. engineering geology and soils engineering symposium; Moscow, ID, USA (2 Apr 1975).

In Engineering geology and soils engineering symposium.

Three techniques for improving shallow refraction data are reviewed. Frequency filtering, directional arrays, and multiplicity summing all have advantages and disadvantages. Frequency filtering requires that the signal and noise fall into different frequency bands, but large attenuation of noise can be realized if the technique is applied properly. An 80 Hz, high pass filter is used to obtain better data in an area with strong 60 Hz induced noise and low frequency traffic noise. A directional array is used to enhance data close to seismic noise caused by traffic, but arrays are cumbersome and difficult to use. Multiplicity summing is a popular improvement technique, and easy to use, however, there is a diminishing return on the field effort applied. It is suggested that under some circumstances the user may wish to use several techniques simultaneously.

38308 Tectonic implications of the Brawley earthquake swarm, Imperial Valley, California, January 1975. Johnson, C.E.; Hadley, D.M. (California Inst. of Tech., Pasadena). *Bull. Seismol. Soc. Am.;* **66**: No. 4, 1133-1144(Aug 1976).

The Brawley earthquake swarm was most intense for a period of 4 days including 75 events with M/sub L/ between 3.0 and 4.7 with a spatial extent of 12 km. Precise relative hypocenters were obtained for 264 earthquakes (M/sub L/ greater than or equal to 1.5) using a master event method to calibrate the USGS Imperial Valley array. These locations together with well-constrained focal mechanisms for 16 of the largest events suggest faulting on at least three distinct structures. Hypocentral depths ranged from 4 to 8 km, compared to a basement depth of about 6 km for this part of the Imperial Valley. The swarm began on a nearly vertical right-lateral fault striking N8 W (Brawley fault) about 8 km southeast of Brawley at a point which had experienced enhanced shallow seismicity during the preceding 4 days. The seismicity migrated bilaterally north and south from this point at a constant velocity of 0.5 km/hr terminating to the north on a steeply south dipping, N50°E-striking fault. This structure is on trend with splays associated with the northern end of ground breakage of the 1940 Imperial Valley earthquake. To the south the seismicity ended near the northern end of the 10 km of surface rupture mapped by R.V. Sharp, which continues on strike to a point near the Imperial fault. Tectonic interpretations include the transfer of right-lateral offset from the Imperial fault to the Brawley fault associated with the formation of a closed depression bounded on the west and east by these two faults.

38309 Surface faulting in Imperial Valley during the earthquake swarm of January—February 1975. Sharp, R.V. (Geological Survey, Menlo Park, CA). *Bull. Seismol. Soc. Am.;* **66**: No. 4, 1145-1154(Aug 1976).

Surface ruptures formed along a 10.4-km segment of the Brawley fault during the earthquake swarm of January and February, 1975, in central Imperial Valley, California. This newly recognized fault appears to branch northward from the Imperial fault about 8 km east-northeast of El Centro. Displacement at the surface was apparently vertical and reached a maximum of probably more than 0.2 m at Keystone Road. En echelon cracking suggested an incipient right-lateral component, but roads and irrigation canals were not laterally offset by the faulting. Surface cracks and most of the displacement probably developed suddenly at the time of the largest shock (M 4.7) in the swarm on January 23. At Harris Road, vertical movement continued at least until March 24, but significant afterslip across the fault zone may have ceased by February 13. Vertical movement after the 13th apparently took the form of a relative subsidence centered on the fault with no important net slip across the fault. Pre-1975 historic displacements on the Brawley fault occurred in 1940 at the time of the M 7.1 Imperial Valley earthquake and probably as intermittent creep between 1940 and 1975.

38310 Strong-motion earthquake accelerograms at Brawley, California: January 25, 1975. Johnson, D.A.; Hanks, T.C. (Geological Survey, Lawndale, CA). *Bull. Seismol. Soc. Am.;* **66**: No. 4, 1155-1158(Aug 1976).

During the Brawley earthquake swarm of January, February, 1975, a single strong-motion accelerograph installed after the swarm began recorded 27 positively identified earthquakes in 14 hr, at hypocentral distances of approximately 5 km. Eight of these had magnitudes (M/sub L/) greater than or equal to 3.5, and several had M/sub L/ less than 2.5; the instrument independently triggered 18 times. Peak accelerations in excess of 10 percent g were obtained for five of the eight earthquakes with M/sub L/ greater than or equal to 3.5, and a peak acceleration of 25 percent g was recorded for the largest event, M/sub L/ = 4.3.

38311 Earthquake sounds generated by body-wave ground motion. Hill, D.P.; Fischer, F.G.; Lahr, K.M.; Coakley, J.M. (Geological Survey, Menlo Park, CA). *Bull. Seismol. Soc. Am.;* **66**: No. 4, 1159-1172(Aug 1976).

Simultaneous recordings of acoustic pressure waves and seismic body waves were obtained for three earthquakes of magnitude 2.0, 2.6, and 2.8 in the Imperial Valley, California, at hypocentral distances of 7 to 8 km. The recordings show that an acoustic signal with frequencies between 50 and 70 Hz begins within 0.02 sec of the P-wave arrival and gradually dies out by the time of the S-wave arrival about 2 sec later. These recordings are consistent with reports that a low rumbling sound frequently accompanied earthquakes in the January 1975 swarm. They also explain reports that the sound was often heard several seconds before the earthquakes were felt in that perceptible shaking apparently begins with the S wave for local earthquakes of magnitude less than about 3. Calculations of the transmission coefficients for seismic P and SV waves converted to acoustic waves at the Earth's surface confirm that body-wave ground motion from local earthquakes is sufficient to generate audible acoustic pressure waves.

38312 Tektonicheskoe razvitie vostochnogo obramleniya Kamchatki. (Tectonic development of the eastern branch of Kamchatka). Shapiro, M.N. Moscow; Izdatel'stvo Nauka (1976). 123p.

This monograph analyzes the main features of the geological formation of Eastern Kamchatka, the Kamandorskii islands and the bottom of adjacent bodies of water. Results are presented of a study of the composition of terrigenic components of a series of strata of this region, and the history of its tectonic development is established. 2 tables, 35 figures, 126 references.

GEOPHYSICAL SURVEY METHODS

REFER ALSO TO CITATION(S) 37956

38313 (CONF-7510172—P1, pp 265-274) **Research activities in remote sensing study group.** Matsuno, K. (Geological Survey of Japan, Kawasaki); Nakamura, Y. 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

Man lives not only in his natural environment but also in one of his own making. It is most important for him to find the conditions under which his two environments harmonize. These conditions must be considered on the local, regional and global scale. Our approach to the application of ERTS data has therefore been in the following fashion: recognition of objects and their physical conditions; recognition of the spatial distribution of the recognized objects and their physical conditions; recognition of time changes in the objects, their physical conditions and their distribution; forecasting; and countermeasures. The environmental destruction with which the

world is now concerned is the result of human activities which exceed nature's carrying capacity.

38314 Approximate method of resistivity sounding interpretation. Koefoed, O. (Technological Univ., Delft, Netherlands). *Geophys. Prospect.;* **24**: No. 4, 617-632(Dec 1976).

From 37. meeting of the European Association of Exploration Geophysicists; Bergen, Norway (Jun 1975).

An approximate method of interpretation of resistivity sounding is presented, which may be described as a very crude manner of application of the exact direct interpretation method. The accuracy of this method is fairly low, the erros being in the order of 25 percent. The method is very fast in application and well suited for application to multilayer cases. The main advantage of the method is that it is in close and clear relation to the exact theory.

38315 Reconn. Bois, P. (Institut Francais du Petrole, Rueil-Malmaison, France). *Geophys. Prospect.;* **24**: No. 4, 696-718(Dec 1976). (In French and English).

From 37. meeting of the European Association of Exploration Geophysicists; Bergen, Norway (Jun 1975).

A complicated geological structure may make it difficult to recognize seismic horizons. This may be the case when blind zones are present, when horizons have to be identified on both sides of a fault, or when lithological facies exhibit a lateral variation. A method for the recognition of seismic reflections is described. The process takes the dynamic range of seismic information into account as well as the extensive logical possibilities of modern computers. The method implements a factorial discriminant analysis of seismic traces by means of a stepwise iterative process. The reliability of results is studied by examining the a posteriori discrimination between different horizons. If the classification is good, a percentage of well classified reflections is given for each horizon.

38316 Long period statics determination by inverse filtering. Kirkham, D.J.; Poggiagliolmi, E. (Digital Exploration Ltd., Sussex, Eng.). *Geophys. Prospect.;* **24**: No. 4, 737-755(Dec 1976).

From 36. meeting of the European Association of Exploration Geophysicists; Madrid, Spain (Jun 1974).

The relative time shift of CDP reflections, caused by long period statics, is treated as the result of a filtering process. The shape of the filter is that of a comb having the magnitude and spacing of its teeth determined by the CDP spread geometry. Convolution of a near surface anomaly with a comb filter representing the CDP spread geometry produces the same time fluctuations at CDP reflections (CDP statics) as the stacked traces across the anomaly. Conversely, the near surface time anomaly is given by the convolution of the CDP statics with the inverse of the comb filter. Provided that CDP statics can be separated from noise, dip, and residual normal moveout, it is possible to determine long period statics with a relative wavelength of between half a spreadlength and five spreadlengths. The object of this paper is to present the theory and practical applications of the method. Several examples based on synthetic and real data are also discussed.

38317 Radiation of acoustic waves from an air-gun. Safar, M.H. (British Petroleum Co. Ltd., Middlesex, Eng.). *Geophys. Prospect.;* **24**: No. 4, 756-772(Dec 1976).

From I.E.R.E. conference on instrumentation in oceanography; Bangor, Wales, Eng. (Sep 1975).

A theoretical model is developed for predicting three important parameters of the pressure pulse radiated by an air-gun, namely the rise time, the amplitude of the initial pulse, and the period of the bubble pulse. A knowledge of these three parameters is essential for the efficient design of air-guns arrays. The prediction of the amplitude of the initial pulse is based on the assumption that the initial pulse is radiated by a spherical source with surface area equal to that of the air-gun ports and not by a spherical source with intial volume equal to that of the air-gun chamber, as has been assumed previously. A simple equation is obtained for predicting the period of the bubble pulsation, taking into account the effect of the air-gun body, boundaries such as the sea-surface and seabed and the presence of a number of identical air-guns placed at the same depth and fired simultaneously.

38318 Efficient design of air-gun arrays. Safar, M.H. (British Petroleum Co. Ltd., Middlesex, Eng.). *Geophys. Prospect.;* **24**: No. 4, 773-787(Dec 1976).

From 37. meeting of the European Association of Exploration Geophysicists; Bergen, Norway (Jun 1975).

A new technique is developed for shaping the pressure bubble pulse radiated by an array of air-guns. It involves the proper spacing of identical units. It is shown that considerable shortening of the pressure bubble pulse can be achieved provided there is sufficient mutual coupling between all the air-guns. The existing air-gun array technique for reducing the bubble pulse involves the redistribution of the energy of the bubble pulses which are produced by an array of variable sized air-guns such that no energy of the bubble pulses is radiated along the perpendicular to the array axis and only the sum of the initial pulses produced by the air-guns forming the array is radiated along that direction. However, the new air-guns array technique involves the damping of the bubble pulses which are produced by an array of identical air-guns by means of mutual interaction and the effective pressure pulse radiated by the array is given by the sum of the damped bubbles pulses produced by the mutually coupled identical air-guns. Preliminary field trials gave results consistent with the theoretical predictions. A comparison between the waveforms of the pressure bubble pulses radiated by a single air-gun and by an array of four identical air-guns shows that, due to the presence of mutual coupling between the four air-guns, effective damping of the bubble pulse radiated by the array is about 50 percent greater than that of the bubble pulse radiated by the single air-gun.

38319 Seismic anomalies associated with local dislocations. Klem-Musatov, K.D.; Kovalevsky, G.L.; Chernyakov, V.G. (Inst. of Geology and Geophysics, Novosibirsk, USSR). *Geol. Geofiz.;* No. 12, 129-153(Dec 1976). (In Russian).

Experimental and theoretical bases for separation of local dislocations, in particular, low-amplitude deformations and faults are discussed in the light of seismic prospecting data. A mathematical description is given with a discussion of dynamic peculiarities of the wave fields over the low-amplitude faults. It was found that the dynamic peculiarities of reflections over the faults are mainly the function of interferences of regular waves from the dislocation flanks with diffracted waves caused by the lack of regular refractions and damping diffracted waves when geometric shadow runs away from the boundaries of geometric shadow of regular reflection. The expressions for the quantitative evaluations of the dislocation parameters are given to determine the predominating effect of each of the above factors as well as dynamic criteria for separation of the low-amplitude dislocations with the break of continuity.

38320 Polarization method in seismic studies. Gal'perin, E.I. (Inst. of Physics of the Earth, Moscow). *Dokl. Akad. Nauk SSSR;* **230**: No. 3, 553-555(21 Sep 1976). (In Russian).

In order to increase substantially the efficiency of seismic studies of complex media it became necessary to use an additional independent parameter of the wave field, the polarization of the oscillations in the seismic waves. The Institute of Earth Physics (USSR) has developed polar correlation which regulates directed reception according to displacement, and polarization filtration by means of which it is possible to study polarization of seismic waves in real media. It has been found that in most cases the seismic waves are polarized nonlinearly. The disruption of polarization by the superimposition of various waves is discussed. Special systems of observations are being developed. 3 references. (SJR)

MINERALOGY, PETROLOGY, AND ROCK MECHANICS

REFER ALSO TO CITATION(S) 36883

38321 (CONF-770440—, pp 368-379) **Stress field engineering.** Colgate, S.A. (Los Alamos Scientific Lab., NM); Petschek, A.G.; Bowers, N.K.; Browning, R.V. 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

The underground stress field can be altered by a local increment increase in the volume. We have found that we can create an increment of volume semi-permanently by injecting a thixotropic finite gel strength fast setting grout (Regulated Fill-up Cement by Dowell) by slow pumping at high pressure. We show analytically that the compressive stress falls as r^{-3}, r the distance from an inclusion in an isotropic medium. If the medium cannot support tension, like rock, then sigma :: r^{-2}. We have performed finite element numerical calculations to demonstrate the stabilization against caving of underground cavity roofs. An overstressed region placed immediately above the roof achieves this. We have calculated the stress distribution formed of multiple overlapping over stressed regions in the shape of a dome underground. The region immediately underneath the dome roof exhibits vertical tension suggesting the possibility of lifting large underground caverns for subsequent caving and in situ mineral extractions. The formation of overstressed regions should also be useful for strengthening of dome, gas reservoirs, waste disposal sites, etc.

38322 (CONF-770440—, pp 392) **New concepts in hydraulic fracturing design.** Jones, A.H. (Terra-Tek, Salt Lake City); Abousayed, A.F.; Simonson, E.R.; Green, S.J.; Clifton, R.J. (Sandia Labs., Albuquerque, NM). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

A large number of massive hydraulic fracturing failures result from the inability to contain the fracture in the "pay zone". Recently, fracture mechanics concepts have been introduced in the analysis of the effectiveness of shale layers to serve as barriers. Techniques had to be developed to determine the critical stress intensity factor and stiffness properties of the different formations, as well as in situ stress measurements for the "pay zone" and the potential barrier formation. These relatively new concepts have been applied in a number of cases to help determine containment within the "pay zone", and to design the pumping rate during the fracturing operation. The new techniques developed are briefly reviewed, and several applications are presented. Fracturing results, as much as possible, are presented.

38323 (CONF-770440—, pp 393-402) **Waves in rocks: effects of fluid saturation and dilatancy.** Nikolaevskii, V.N. (Inst. of Physics of the Earth, Moscow). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

Very often for theoretical prediction and for proper analysis of mechanical effects of underground explosions and of further deformations of rock masses, it is necessary to take into account such essential features as saturation of pore space with water or oil and changes of pore volume with shear.

38324 (CONF-770440—, pp 416) **Effects of hydrazine hydrate on Berea Sandstone.** El-Messidi, A. (Bechtel Corp., Houston, TX). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

Aqueous solutions of hydrazine have been shown to be effective in changing the characteristics of Berea Sandstone. Different concentrations of hydrazine hydrate ranging from 10 to 90 percent have been investigated and showed different results with respect to time. The data obtained from this research showed that the maximum permissible concentration of hydrazine is 20 percent, above which samples become fragile and cannot be tested in the laboratory. Samples were treated and tested under a constant temperature of 77°F, and their properties, permeability, porosity, compressive strength have been measured and recorded before and after each treatment. Most of the data obtained can show that there is no evidence of improvement in these characteristic of Berea Sandstone at different concentrations of hydrazine hydrate, and different time of treatment. The reason for this damage effect has been attributed to clay mineral content in the rock, especially kaolinite, and its reaction with the hydrazine hydrate where some organo-clay complex is formed. X-ray diffraction analysis of untreated samples indicated that the major clay mineral kaolinite was present and it exists in relatively small abundance (less than 1 percent of the rock by volume). X-ray analysis of the treated samples show the elimination of the characteristic 7.16A° basal spacing of kaolinite. The expected 10.4A° spacing of the hydrazine-kaolinite complex did not however appear. Although no positive proof of the existence of the 10.4A° hydrazine-kaolinite complex was found, the experimental data are interpreted on the premise that a reaction between the hydrazine solution and kaolinite did occur, with a subsequent expansion of the basal spacing from 7.16A° to the reported 10.4A°.

38325 (CONF-770440—, pp 458-467) **Fracture mechanics concepts applied to rocks.** Conrad, N.; Daneshy, A.A. (Halliburton Services, Duncan, OK). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

The application of fracture mechanics in determining the relative vulnerability of four types of rocks (Bedford limestone, Carthage limestone, Leuders limestone, and Pecos sandstone) is shown. It was done by ranking the rocks by fracture toughness tests and by direct comparison tests of two rocks at a time. Agreement was obtained between the results. (JSR)

38326 (CONF-770440—, pp 673-683) **Anisotropic creation and colosure of tension induced fractures.** Burton, D.E.; Lettis, L.A.; Bryan, J.B.; Butkovich, T.R.; Bruce, A.L. (Univ. of California, Livermore). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

A material model is presented which simulates the anisotropic creation and closure of tension-induced fractures. The relationship of the model to explosive-enhanced permeability of geologic formations is discussed. The model is introduced into a two-dimensional finite-difference computer code, and the tensile fracture effects produced by a long cylindrical explosive charge detonated beneath a free surface are calculated.

38327 (CONF-770440—, pp 791-803) **Deformations and stress changes that result from quarrying the Barre Granite of Vermont.** Nichols, T.C. Jr.; Savage, W.Z.; Brethauer, G.E. (Geological Survey, Denver). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

Strain measurements obtained in field and laboratory experiments demonstrate that recoverable instantaneous and time-dependent strains exist in many rock masses. Many of the observed strains are nearly an order of magnitude too large to be explained by present-day gravity loads. At Barre, Vt., the quarrying of a 10 x 10 x 5.7-m block of Devonian Barre Granite caused measurable initial and time-dependent deformations. Such deformations result from readjustments of a newly freed block to a new state of equilibrium. Deformations measured on the surfaces of the block showed the time-dependent deformations induced by quarrying to be generally greater than or comparable to the initial deformations. Similarly, deformations determined by strain-relief methods show the time-dependent changes to be comparable to or larger than the initial changes. Laboratory strain-relief measurements of cores removed from the block before and after quarrying demonstrated time-dependent strains as large as 750 x 10^{-6}. The response to changing boundary configurations by quarrying appears to be both instantaneous and time dependent. Generally stresses and strains relax with time either to zero or to some constant value, after quarrying; this relaxation is seen near ancient fractures, where measured strain magnitudes are small. At times, however, quarrying results in instabilities such as bucking and local rock failures. Such instabilities may be critical to newly made surface or underground installations.

38328 (CONF-7504139—, pp 169-185) **Geotechnical parameters and their relationship to rock resistivity.** Donaldson, P.R. (Boise State Univ., ID). 1975.

From 13. engineering geology and soils engineering symposium; Moscow, ID, USA (2 Apr 1975).

In Engineering geology and oils engineering symposium.

Electrical resistivity is controlled in large part by the amount of fluid filled pore volume in a rock. Rock strength and other geotechnical parameters are also affected by porosity, among other factors. The mutual dependence of these seemingly unrelated properties upon a common controlling factor explains predictable and demonstrable correlations which exist between them. These correlations suggest that resistivity measurements can be used as a qualitative guide in evaluating an area as to its engineering properties. The advantage of using resistivity measurements lies in the fact that they can be made more rapidly and cheaply than direct or other indirect methods of determining engineering rock properties. This fulfills a need for a technique to classify large areas of ground, with respect to their engineering properties, at an early reconnaissance stage in selecting sites for installations that require special strength characteristics in the earth.

38329 (SAND—77-0408) **Prediction of tensile strength of rock from fracture toughness or effective surface energy.** Schmidt, R.A.; Ingraffea, A.R. (Sandia Labs., Albuquerque, N.Mex. (USA); Cornell Univ., Ithaca, N.Y. (USA). School of Civil and Environmental Engineering). Jan 1978. Contract EY-76-C-04-0789. 15p. Dep. NTIS, PC A02/MF A01.

Data are presented that indicate a possible unique relationship between apparent fracture toughness, K/sub Q/, and crack length for Indiana limestone regardless of specimen and crack configuration. Vast improvements are then possible for the prediction of tensile strength from fracture toughness and flaw size data when consideration is given to this effect of crack length on K/sub Q/. A calculated tensile strength for Indiana limestone was 28 percent high and 3 percent low when compared with two recently measured values from direct pull tests. Effective surface energy, γ/sub eff/, can also be used in this approach instead of fracture toughness since the two are directly related.

38330 (SAND—78-0394C) **Puff 'n tuff, a residual stress-gas fracturing experiment.** Smith, C.W.; Bass, R.C.; Tyler, L.D. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1978. Contract EY-76-C-04-0789. 13p. (CONF-780509—6). Dep. NTIS, PC A02/MF A01.

From 19. symposium on rock mechanics; Lake Tahoe, NV, USA (1 May 1978).

Portions of document are illegible.

Subsequent to the dynamic effects from a contained explosion in rock there remains a residual stress field around the cavity. This field is associated with the dynamic rebound of the cavity. Calculations show that the radial component of the residual stress field is compressive, exhibits a maximum near the cavity, and decays to the in situ stress value. The tangential component shows a greater compressive value than the radial component, decays to a value

below the in situ stress, and subsequently rises up to the in situ value. This residual stress effect is believed to be responsible for containment of underground explosions, for calculations show residual cavity pressures to be greater than the sum of the tensile strength of the rock and the overburden stress. A chemical explosion was conducted in an ash fall tuff at a depth of 425 meters and near a tunnel complex. The latter allows subsequent mineback. The experiment involved a 116 kg TNT sphere and a 0.2 meter diameter hole extending radially in the tuff from the emplaced charge. In effect, this provided an opening through the explosively formed residual stress field. Based on this experiment, an inexpensive fracturing technique for tight geologic formations is suggested.

38331 Chemical analysis of brines from fluids inclusions in euhedral quartz and dolomite from the Rabbit Lake uranium deposit (Canada). Pagel, M.; Jaffrezic, H. *C. R. Hebd. Seances Acad. Sci., Ser. D;* **284**: No. 2, 113-116(10 Jan 1977). (In French).

Ionic ratios in brines from fluid inclusions in euhedral quartz and dolomite from the Rabbit Lake uranium deposit were studied first by atomic absorption and colorimetry and second by neutron activation. Results obtained by the two methods agree closely. Quartz and dolimite contain a Na-Ca-Cl brine with a low Cl/Br weight ratio, respectively 55 and 65. The K/Na atomic ratio for quartz is 0.09. These brines are considered as diagenetic fluids derived from the Athabasca sandstones, modified by reactions with rocks from the basement.

38332 Hydrothermal mineralogy of Keolu Hills, Oahu, Hawaii. Fujishima, K.Y.; Fan, P.F. (Univ. of Hawaii, Honululu). *Am. Mineral;* **62**: No. 5/6, 574-582(1977).

The mineralogy of the hydrothermally altered basalts of the Kailua Volcanic Series from Keolu Hills, Oahu, Hawaii, was examined by x-ray diffraction analysis. Vertical and horizontal clay-mineral alteration zones were found. In the vertical zones, mixed-layer chlorite-vermiculite occurs more commonly than chlorite, whereas in the horizontal zones, mixed-layer chlorite-montmorillonite and chlorite are both more common. The occurrence of the two clay minerals kaolinite and mixed-layer chlorite-montmorillonite in the soil is not related to the parent rock but to differences in drainage. The zeolites are calcium zeolites which commonly coexist with quartz; laumontite is the dominant zeolite in the study area. The widespread distribution of laumontite in the Kailua Volcanic Series suggests that low temperatures (approximately 300°C) prevailed during the formation of secondary minerals and indicates that as much as 3,500 feet of weathering has occurred since caldera formation.

GEOCHEMISTRY

REFER ALSO TO CITATION(S) 36842, 37780

38333 (ORNL/SUB—3673/3) **Chemical, mineralogical, and thermogravimetric analyses of selected core samples from Carlsbad, New Mexico.** Beane, R.E.; Popp, C.J. (New Mexico Inst. of Mining and Technology, Socorro (USA)). Jun 1975. Contract W-7405-ENG-26. 243p. Dep. NTIS, PC A11/MF A01.

Data are presented from whole-rock chemical analysis, determination of soluble-insoluble fractions, and weight losses upon heating of core samples from Carlsbad, New Mexico. Analytical techniques used are described.

OCEANOGRAPHY

REFER ALSO TO CITATION(S) 38053, 38056, 38061

38334 (SRO—902-5) **Continental shelf processes affecting the oceanography of the South Atlantic Bight. Progress report.** Pietrafesa, L.J. (North Carolina State Univ., Raleigh (USA)). 1 Mar 1978. Contract EY-76-S-09-0902. 326p. Dep. NTIS, PC A15/MF A01.

The objectives of the project were to determine the physical/dynamical processes controlling/affecting the distribution of phytoplankton nutrients on the continental shelf in the South Atlantic Bight. The initial objectives were to determine the short term, i.e., 2 to 10 day and longer term flux of nutrients onto the continental shelf. This is clearly related to the more general problem of combined physical and biogenic control of phytoplankton nutrients. During the period from June, 1975 to March, 1978 the study of the continental shelf processes affecting the oceanography of the South Atlantic Bight has been principally involved with a substantial, coordinated field effort. The success of the data acquisition phase of the program has now required an intensive data analysis phase which has been slowly increasing in effort. Emphasis is placed on the main phase of the field program, located in Onslow Bay, which has beel completed and the data are being analyzed. During the three-year period 20 cruises were made into the Carolina Capes area and samples were collected. A list is included of some 100 publications during the period.

38335 (SRO—902-12) **Effects of buoyancy flux on continental shelf circulation.** Pietrafesa, L.J.; Janowitz, G.S. (North Carolina State Univ., Raleigh (USA)). [nd]. Contract EY-76-S-09-0902. 32p. Dep. NTIS, PC A03/MF A01.

The effects of buoyancy flux at the surface of a two-dimensional, steady state, continuously stratified continental shelf have been considered. Similarity solutions have been generated using an interative technique. The solutions incorporate the influences of mechanical wind forcing, eddy diffusion, surface buoyancy flux and bottom topography. The traverse circulation can be decomposed into modes associated with the surface wind stress and the surface buoyancy flux and modified by stratification, mixing and bottom topography. For the special cases of a wind stress with zero curl or for zero wind stress, upwelling circulations can be induced by both the sloping bottom and by gravitational convective effects. Alongshore interior currents counter to the direction of the wind are observed and are attributed to baroclinic pressure gradients. The nature of the transverse and alongshore flows are characterized in terms of dimensionless ratios of: Coriolis to frictional forces, buoyancy to frictional forces; convective to diffusive forces; and horizontal to vertical mixing time scales and length scales.

38336 (SRO—902-13) **Applications of a revived Euler—Shohat Perturbation expansion technique in the study of ocean circulation.** Pietrafesa, L.J.; Struble, R.A.; Klinck, J.M. (North Carolina State Univ., Raleigh (USA)). 1974. Contract EY-76-S-09-0902. 23p. Dep. NTIS, PC A02/MF A01.

Consideration of geophysical vertical plane flows in estuaries and on continental shelves results in nonlinearly coupled partial differential equations for flow and density variables. For the case of steady flow, the equations are reduced to ordinary differential equations by the use of similarity transformations. The remaining nonlinearly coupled ordinary differential equations are solved using a revised Euler-Shohat perturbation technique. An existence theorem for this application of the technique is stated and proved.

PHYSICS RESEARCH

ASTROPHYSICS AND COSMOLOGY

COSMIC RADIATION

38337 (EML—338) **LUIN, a code for the calculation of cosmic ray propagation in the atmosphere.** O'Brien, K. (Department of Energy, New York (USA). Environmental Measurements Lab.). Feb 1978. 22p. Dep. NTIS, PC A02/MF A01.

Update of HASL—275.

This report is an update of the code published as HASL-275 (May 1973). An analytical straight-ahead transport code, LUIN, was developed for the calculation of cosmic-ray spectra, fluxes, and ionization in the earth's atmosphere. The input to the code is described, along with an ancillary code to prepare the angle-dependent rigidity cut-off input. LUIN takes into account solar modulation, the geomagnetic field, atmospheric temperature, altitude and the curvature of the earth. The code is written in FORTRAN IV for the CDC 6600. 5 tables.

38338 Cosmic gamma radiation. Boerner, G. (Max-Planck Institut fuer Physik und Astrophysik, Munich). *Acta Phys. Austriaca, Suppl.;* No. 18, 789-834(1977).

From XVI proceedings on contacts between high energy physics and other fields of physics; Schladming, Austria (24 Feb 1977).

See CONF-770257—.

A brief history and properties of the cosmic gamma radiation is given. Then the diffuse component, gamma ray lines, gamma ray pulsars, and cosmic gamma bursts are discussed. 41 references. (JFP)

STARS

38339 Magnetohydrodynamics near a black hole. Wilson, J.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). pp 393-413 of Marcel Grossmann meeting on general relativity. Ruffini, R. (ed.) (Rome Univ. (Italy). Istituto di Fisica). Amsterdam; North-Holland Publishing Co. (1977).

From Meeting on the recent progress of the fundamentals of general relativity miramare; Trieste, Italy (7 Jul 1975).

See CONF-750734—.

In this paper a numerical computer study of hydromagnetic flow near a black hole is presented. First, the equations of motion are developed to a form suitable for numerical computations. Second, the results of calculations describing the magnetic torques exerted by a rotating black hole on a surrounding magnetic plasma and the electric charge that is induced on the surface of the black hole are presented.

38340 Quark star phenomenology. Freedman, B.; McLerran, L. (Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Rev., D;* **17**: No. 4, 1109-1122(15 Feb 1978).

We analyze models of quark matter appropriate to the description of matter at densities found within neutron stars. We consider in detail two models: quantum chromodynamics with a bag constant B = 56 MeV/fm^3, and quantum chromodynamics with B = 0. Both models are consistent with the strength of the quark-quark force found in high-energy particle phenomenology. The pressure, energy density per baryon, and baryon density are calculated. An interesting prediction of our models is that a quark star should have strangeness comparable to its baryon number.

38341 Measurement of the cross section for photoionization of ytterbium in the $3P_1$ excited state. Ishchenko, V.N.; Karlov, N.V.; Krynetskii, B.B.; Lisitsyn, V.N.; Mishin, V.A.; Razhev, A.M. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. Tech. Phys. Lett. (Engl. Transl.);* **3**: No. 10, 428-429(Oct 1977).

A specially designed XeCl laser was used to measure the Yb photoionization cross section in the ultraviolet region.

38342 Models for type I supernovae. Nadezhin, D.K.; Utrobin, V.P. (Institute of Applied Mathematics, USSR Academy of Sciences, Moscow). *Sov. Astron. AJ (Engl. Transl.);* **21**: No. 5, 564-571(Sep 1977).

A previous analysis of model supernovae assuming a slow injection of energy is here continued. The principal characteristics of a supernova near maximum light depend weakly on the chemical composition of the envelope, and are practically independent of the spatial parameters describing the energy production. However, these characteristics are sensitive to the total energy output E_0 and to the time scale t/sub x/ of the energy generation law. The calculated supernova parameters depend strongly on the mass of the ejected envelope. The maxima in B and V light will lag behind the bolometric maximum, and the effect is evaluated for several cases. Premaximum observations of supernovae would be valuable since they would, in principle, permit t/sub x/ to be estimated from the observed time dependence of the photosphere radius. A working model for a type I supernova outburst is proposed, with the following main phases of development: a) A primary shock wave emerges and ejects a comparatively low mass (≃0.01 M/sub sun/) atmosphere with a steep velocity gradient, responsible for the subsequent line spectrum of the supernova. b) Slow energy release then ejects an envelope of ≃0.5 M/sub sun/ in the form of a thin spherical shell, responsible for the hump in the light curve and for the continuous spectrum of the supernova. c) The activity of the central supernova remnant would account for the persistent emission in the exponential tail of the light curve. Theoretical light and B-V color-index curves are presented graphically. Observational comparison shows that the total energy released in a typical type I outburst is (2-5) x 10^{50} erg, and the mass of the ejected envelope is 0.3-0.6 M/sub sun/.

38343 Triggering of stellar collapse by thermonuclear burning in a degenerate carbon core. Ivanova, L.N.; Imshennik, V.S.; Chechetkin, V.M. (Institute of Applied Mathematics, USSR Academy of Sciences, Moscow). *Sov. Astron. AJ (Engl. Transl.);* **21**: No. 5, 571-581(Sep 1977).

The evolution of carbon stellar cores of mas M≃1.4 M/sub sun/ will result in a carbon flash for a range of central densities: 2 x 10^9 <rho/sub c/<3 x 10^{10} g/cm^3. The lower limit corresponds to normal evolution of a single star; the upper value is equal to the Chandrasekhar limit for carbon white dwarfs. If rho/sub c/> or ≃5 x 10^9 g/cm^3, thermonuclear burning as the carbon flash progresses will lead to gravitational collapse, probably terminating with the formation of a neutron star. A hydrodynamic theory for a carbon flash is developed on the basis of a deflagration mechanism for carbon burning, and it allows fully for all physical processes significant in strongly degenerate matter except for neutrino opacity. The flash is calculated for two models in hydrostatic equilibrium with initial values rho/sub c/ =8.36 x 10^9 and 5.04 x 10^9 g/cm^3. The results are compared with calculations of the collapse of 1.2-2 M/sub sun/ iron cores. A collapsing carbon core will have an entropy several times smaller than an iron core of comparable mass. No envelope is found to be ejected during the collapse process.

38344 Transfer of angular momentum during steady disk accretion. Gorbatskii, V.G. (A. A. Zhdanov Leningrad State University). *Sov. Astron. AJ (Engl. Transl.);* **21**: No. 5, 587-589(Sep 1977).

The conditions of steady disk accretion are analyzed. It is shown that accretion can be independent of time only if there is an inflow of mass and angular momentum through the outer boundary of the disk. All the angular momentum reaching this boundary is transferred through the disk to the surface of the central star.

38345 Estimation of the critical parameters of degenerate magnetic white dwarfs. Shul'man, G.A. (Department of General and Theoretical Physics, Brest State Pedagogical Insitute). *Sov. Astron. AJ (Engl. Transl.);* **21**: No. 5, 590-593(Sep 1977).

Using the approximate energetic method the limiting mass and central density of a degenerate magnetic white dwarf are estimated on the assumption of conservation of magnetic flux in its interior and with allowance for correction terms responsible for the effects of the general theory of relativity and for neutronization.

38346 Gravitational radiation of neutron stars and white dwarfs. Vartanyan, Y.L.; Adzhyan, G.S. (Erevan State University). *Sov. Astron. AJ (Engl. Transl.);* **21**: No. 5, 593-594(Sep 1977).

The possibility of the generation of gravitational radiation by similar pulsations of rotating ablate neutron stars and white dwarfs is analyzed. The angular distribution, polarization, intensity, and characteristic damping time of such radiation are calculated. These quantities are estimated for rapidly rotating neutron stars and white dwarfs.

38347 Magnetopause of an accreting neutron star. Basko, M.M. (Institute for Space Research, Academy of Sciences of the USSR). *Sov. Astron. AJ (Engl. Transl.);* **21**: No. 5, 595-600(Sep 1977).

The shape of the Alfven surface separating the magnetosphere of a neutron star from the stream of accreting plasma and the velocity and scattering optical depth of the gas layer flowing along the Alfven surface are calculated. Calculations are made both for spherically symmetrical fall of the gas and for disk accretion. It is shown that the fall of matter from the Alfven radius to the surface of the neutron star is possible only with the condition of "freezing" of the plasma into the magnetic field of the star.

38348 Stability of nonlinear nonradial oscillations in two-dimensional models of rotating stellar systems. Antonov, V.A.; Nuritdinov, S.N. (Leningrad University Observatory). *Sov. Astron. AJ (Engl. Transl.);* **21**: No. 4, 420-424(Jul 1977).

An analysis is made of some topics concerning the nonlinear stability of a circular cylinder and a Maclaurin disk against nonradial oscillations which tend to give the system an elliptical shape, while maintaining a homogeneous space density in the disturbed state. Time-independent phase invariants are defined. The total energy of the two-dimensional model is minimized under the condition that the invariants be conserved. For the nonlinear oscillations considered, stability conditions are established in the form of an upper limit on the centroid velocity Ω. For the cylinder, Ω<1, and for the disk, Ω< or = (125/486)/sup 1/2/, in units of the circular velocity; these values agree with the stability criteria of the linear approximation. The coincidence of the limiting values evidently results from the fact that only affine oscillations have been examined.

38349 Hydrogen abundance in type I supernovae and supernova remnants. Bychkova, V.S.; Bychkov, K.V. (Special Astrophysical Observatory, USSR Academy of Sciences). *Sov. Astron. AJ (Engl. Transl.);* **21**: No. 4, 435-440(Jul 1977).

The steady-state equations for the hydrogen atom are solved, confirming the anomalously low hydrogen abundance in type I supernovae found previously by other authors from models assuming local thermodynamic equilibrium. Atoms leave the second and third levels mainly through photoionization by the continuum radiation of the supernova itself. The falloff observed for type I supernova spectra in the ultraviolet implies that the ratio of atoms on the second and third levels is greater than in the LTE case; as a result an absorption line should appear, and its absence indicates that the hydrogen abundance is deficient. On the other hand, the filaments in the Crab and Kepler nebulae, whose hydrogen abundance is nearly normal, should consist of gas coming from the supernova atmospheres themselves. These two facts can be reconciled in terms of a model involving an outflow of stellar wind prior to the explosion if hydrogen-rich layers are assumed to be thrown off by the star at that time. These layers would become visible only after they have been overtaken, swept up, and heated by the fast envelope ejected in the supernova outburst. Observations to confirm the model are proposed. In particular, the Kepler nebula may contain filaments both rich and poor in hydrogen; secondly, during a supernova outburst the layers produced by the prior stellar wind might be manifested by comparatively narrow and less shifted absorption lines.

38350 Model for the "atmosphere" of stars around a massive black hole. Dokuchaev, V.I.; Ozernoi, L.M. (Lebedev Physics Institute, USSR Academy of Sciences, Moscow). *Sov. Astron. Lett. (Engl. Transl.);* **3**: No. 4, 157-159(Jul 1977).

A model is developed for a spherical system of N stars of equal mass m surrounding a black hole of mass M/sub h/>>mN. The consumption rate: the flux of stars of low angular momentum into the sphere of tidal disruption by the black hole: is calculated, allowing for repopulation of the loss cone by the stars due to diffusion of their orbits with respect to angular momentum. The corresponding distribution law for stars around the black hole is derived.

38351 Gravitational collapse of rotating iron-oxygen stars. Imshennik, V.S.; Nadezhin, D.K. (Institute of Applied Mathematics, USSR Academy of Sciences, Moscow). *Sov. Astron. Lett. (Engl. Transl.);* **3**: No. 4, 188-191(Jul 1977).

The gravitational collapse of a rotating iron-oxygen star of 2 M/sub sun/ is calculated. A one-dimensional approximation is adopted for the rotation, with the centrifugal force averaged over solid angle. No significant ejection of an envelope will take place. The rotation may appreciably diminish the neutrino luminosity of the collapsing star.

38352 Magnetic intensification of lines in the spectra of cool Ap stars. Kolev, D.Z. *Sov. Astron. Lett. (Engl. Transl.);* **3**: No. 4, 194-196(Jul 1977).

By comparing the observed and theoretical (W/sub lambda/, log gf) relations for the lines of a definite supermultiplet, one can measure the magnetic intensification of the lines. A method is proposed for estimating the magnetic field strength from the relative enhancement of lines with differing displacement z but similar log gf.

38353 "Splendeurs et miseres" of Hawking's effect. Hijicek, P. (Inst. for Theoreticsl Physics, Bern). *Acta Phys. Austriaca, Suppl.;* No. 18, 835-872(1977).

From XVI proceedings on contacts between high energy physics and other fields of physics; Schladming, Austria (24 Feb 1977).

See CONF-770257—.

The Hawking effect, the result that a Schwarzschild black hole will emit particles as if it were a hot body with a given temperature depending upon the mass of the hole and the sun, the Planck, Newton, and Boltzmann constants, and the light velocity, is considered. Restriction is made to the Schwarzschild space-time, in order to suppress the geometrical, purely general relativistic aspects as far as possible. The treatment includes quantum field theory in curved space—times, and spherically symmetric collapse. 23 references. (JFP)

QUASI-STELLAR, RADIO, AND X-RAY SOURCES

38354 Interpretation of the light curves of eclipsing binaries with disklike envelopes. The HZ Herculis system. Cherepashchuk, A.M.; Goncharskii, A.V.; Yagola, A.G. (Shternberg Astronomical Institute, Moscow and Physics Faculty, Moscow University). *Sov. Astron. AJ (Engl. Transl.);* **21**: No. 5, 581-586(Sep 1977).

A method is proposed for restoring the structure of the accretion disk in a binary system from analysis of eclipse curves. Application of the method to the x-ray binary HZ Herculis yields the distribution of brightness and color temperatures over the optical accretion disk associated with the neutron star. The luminosity, mean temperature, and size of the disk are correlated with the phase of the 35-day cycle of x-ray variability. The empirical parameters derived for the accretion disk agree with the theory of disk accretion onto relativistic objects.

38355 Nature of pulsar gamma rays. Ozernoi, L.M.; Usov, V.V. (Lebedev Physics Institute, USSR Academy of Sciences, Moscow). *Sov. Astron. AJ (Engl. Transl.);* **21**: No. 4, 425-431(Jul 1977).

The generation of γ rays due to the curvature of the magnetic field lines and their escape from the neighborhood of a pulsar are discussed. With allowance for the production by γ-ray photons of electron-positron pairs in a strong magnetic field, the distance at which the γ rays begin freely to leave the pulsar neighborhood is determined. Estimates are obtained for the power of the γ rays and the frequency of the emission maximum. The values obtained are in reasonable accord with the observed γ-ray parameters for both young pulsars (NP 0532, PSR 0833-45) and relatively old ones (PSR 1747-46, PSR 1818-04). In general the directional pattern of pulsar γ rays will not coincide with the radio beam. This circumstance may explain the phase shift of the γ-ray pulses relative to the radio pulses observed in three of the four γ-ray pulsars known prior to 1977, as well as the fact that γ rays have thus far been observed for only two old pulsars. The model developed here predicts that γ-ray pulsars without appreciable radio emission should exist; many of them could be members of binary systems.

38356 Instability of a pulsar magnetosphere. Pustil'nik, L.A. (Special Astrophysical Observatory, USSR Academy of Sciences). *Sov. Astron. AJ (Engl. Transl.);* **21**: No. 4, 432-435(Jul 1977).

A stability analysis is made for a pulsar magnetosphere in which particles ejected from the neutron-star surface by the electric field have collected. At the epoch when the density of the magnetospheric plasma exceeds a critical value rho/sub cr/, the magnetosphere should become destabilized, and a gutter or flute of plasma carrying the field should be thrust outward toward the light cylinder. The density rho/sub cr/ is determined as a function of the pulsar parameters M_0, Ω, and H_0. A numerical estimate is thereby obtained for the observable manifestations of the destabilization: the glitch $\Delta\Omega/\Omega$ in the pulsar rotation frequency, the mass M/sub asterisk/ of the material ejected, and the accumulation time T/sub cr/. These values are consistent with the glitches observed in the Crab Nebula and Vela pulsars. During the intervals between such ejections into the pulsar magnetosphere, oscillations should build up, serving to modulate the properties of the pulsar radiation on a time scale tau/sub approximately/9 or $\approx[(0.2\text{-}0.3)\ \Omega]^{-1}$. One important feature of these modes is a sharp rise in their amplitude and period up to the time the magnetosphere is destabilized. This effect would permit an experimental test of the correctness of the interpretation proposed, and it would also enable one to forecast the time when a glitch in the spin frequency should occur and plasma should be ejected into the space around the pulsar.

38357 Cygnus X-3: A binary system with an active pulsar. Tsygan, A.I. (Ioffe Physics and Technology Institute, USSR Academy of Sciences, Leningrad). *Sov. Astron. Lett. (Engl. Transl.);* **3**: No. 4, 160-161(Jul 1977).

The Cygnus X-3 binary system could have an active, ejecting pulsar with an age $t\approx10^5$ yr. Over this time span the nebula resulting from the supernova outburst would have faded from visibility. The magnetic field strength on the surface of the neutron star is $H\sin\theta\approx5\times10^{10}$ gauss, and the rotation period $P\approx4\times10^{-3}$ sec. These parameters would maintain the system at its full luminosity of $\approx3\times10^{38}$ erg/sec for $\approx10^5$ yr.

38358 Nature of the AM Herculis system (3U 1809+50). Mitrofanov, I.G.; Pavlov, G.G.; Gnedin, Y.N. (Ioffe Physics and Technology Institute, USSR Academy of Sciences, Leningrad). *Sov. Astron. Lett. (Engl. Transl.);* **3**: No. 4, 182-184(Jul 1977).

The substantial linear and circular polarization of the optical radiation of AM Her is generated in the photosphere of a degenerate dwarf, a member of a close binary system, with a magnetic field strength B> or $\approx2\times10^8$ gauss. The distance of the system is > or ≈10 pc. X rays are produced by accretion of matter onto the magnetized dwarf. The nondegenerate star is embedded in the dwarf's magnetosphere. Nonsteady mass transfer would explain the variability in the ultraviolet and x-ray brightness and the flare activity of AM Her.

SOLAR PHENOMENA

38359 Direct observation of the latitudinal extent of a high-speed stream in the solar wind. Schwenn, R.; Montgomery, M.D.; Rosenbauer, H.; Miggenrieder, H.; Muehlhaeuser, K.H.; Bame, S.J.; Feldman, W.C.; Hansen, R.T. (Max-Planck-Institut fuer Physik und Astrophysik, Institut fuer Extraterrestrische Physik, 8046 Garching/Munich, West Germany). *J. Geophys. Res.;* **83**: No. A3, 1011-1017(1 Mar 1978).

Solar wind speeds measured from the Helios 1 solar probe between 0.31 and 1 AU and the earth-orbiting Imp 7/8 satellites have been correlated with coronal holes as determined from K coronal brightness measurements. In March 1975 during perihelion passage, Helios 1 traversed the range of heliographic latitudes from -6° to $+6^\circ$ in a period of only 20 days. During that time the space probe crossed the northern boundary of the high-speed stream associated with an equatorward extension of the south polar coronal hole. While this same stream continued to be observed by Imp satellites at -5° latitude, it was no longer observable from Helios 1 at $+5^\circ$ latitude. The conclusion is that sharp boundaries separate high-speed flows from the surrounding solar wind. The thickness of the boundary in latitude appears to be narrower than about 10°. The local latitudinal gradient in flow speed is at least 30 km s^{-1} deg^{-1}. With less confidence it can be deduced from the Helios 1 data that the actual gradients at 0.31 AU might even exceed 100 km s^{-1} deg^{-1}.

38360 X-ray and ultraviolet emission and the physics of solar flares. Pikel'ner, S.B.; Livshits, M.A. (P. K. Shternberg State Astronomical Institute. Institute of Terrestrial Magnetism, the Ionosphere, and Radio-Wave Propagation, Academy of Sciences of the USSR). *Sov. Astron. AJ (Engl. Transl.);* **21**: No. 5, 601-611(Sep 1977).

Observations of the pulsed and slow components and of the polarization of the x-ray emission of solar flares are used to clarify the contributions of the thermal and nonthermal components and to determine the characteristics of the streams of accelerated electrons. The energies of the electron beam and of the high-temperature cloud formed during flares are estimated. The bursts of UV emission in the 300-1800 A region are analyzed. The heating of lower layers of the atmosphere by the heat flux and by the accelerated particles is

analyzed with allowance for the motions which develop in the process. The role of the magnetic field and the demands on the theory of flares introduced by extra-atmospheric observations are briefly discussed.

38361 Dissipation of convective noise waves in the magnetic structure of the upper layers of the solar atmosphere. Kaplan, S.A.; Pykhina, G.B. (Scientific-Research Radiophysics Institute, Gor'kii). *Sov. Astron. AJ (Engl. Transl.);* **21**: No. 5, 626-630(Sep 1977).

The dissipation depths of Alfven and sound waves in the magnetic structure of the solar chromosphere and corona are obtained with allowance for the decay process and nonlinear phase advance in Alfven and sound waves. In the calculations it was assumed that energy balance occurs in each volume element: The amount of wave energy ϵ/sub dis/ dissipated here is equal to the emission power ϵ/sub emis/. The calculations were made for three mechanisms of losses to emission, namely, in accordance with a) a given population of the second level, b) a Boltzmann distribution by levels, and c) emission at high temperatures in accordance with the results of [D. P. Cox and W. H. Tucker, Astrophys. J. 157, 1157 (1969)]. The depths are given in Table I. Sound waves dissipate rapidly both in the chromosphere and in the corona. Under certain conditions, which can be estimated from Eqs. (17) -(19), taking phi/ π and μ on the order of unity there, Alfven waves penetrate to greater heights, and at the same time the dissipation of these waves in magnetic tubes is still sufficient for the heating.

38362 Nonlinear magnetohydrodynamic model of the solar dynamo. Ivanova, T.S.; Ruzmaikin, A.A. (Institute of Applied Mathematics, Academy of Sciences of the USSR). *Sov. Astron. AJ (Engl. Transl.);* **21**: No. 4, 479-485(Jul 1977).

A numerical solution is constructed for the simplest nonlinear dynamo model of the generation of the large-scale magnetic field in the convective zone of the sun. The nonlinearity is introduced by varying the form of the function α describing the helicity of the velocity field. The suppression of growing oscillations occurs as a result, and the solution enters into a steady state with a definite period and amplitude. The phase relations between the meridional and azimuthal components of the magnetic field, which result in the limitation $d\omega/dr<0$ on the depth dependence of the angular velocity of the convective zone, are discussed. The butterfly diagram agrees qualitatively with what is observed. Estimates of the dynamo number, the period, and the amplitude in the steady state also indicate good agreement with observations.

38363 Localization on the sun of regions of outflow of quasi-steady high-velocity streams of solar wind. Kovalenko, V.A.; Molodykh, S.I. (Siberian Institute of Terrestrial Magnetism, the Ionosphere, and Radio-Wave Propagation, Siberian Branch of the Academy of Sciences of the USSR). *Sov. Astron. AJ (Engl. Transl.);* **21**: No. 4, 486-491(Jul 1977).

An analysis is made of the characteristics of regions on the sun which are the sources of quasi-steady high-velocity streams (HS) of solar wind. It is found that HS are localized in regions of the corona with an open nonradially diverging configuration of magnetic fields. These regions are characterized by a low level of coronal emission and a reduced concentration and, as a rule, are adjacent to coronal condensations. On this basis one is able to understand the properties of the variation in the velocities of HS during a cycle of solar activity. The results obtained confirm a model of HS proposed earlier by the authors.

38364 Impulsive flare heating according to ultraviolet observations of the sun. Syrovatskii, S.I.; Shmeleva, O.P. (Lebedev Physics Institute, USSR Academy of Sciences, Moscow). *Sov. Astron. Lett. (Engl. Transl.);* **3**: No. 4, 168-170(Jul 1977).

The heating of the chromosphere by solar flares as previously calculated theoretically for two regimes, impulsive heating (constant density) and prolonged, continuous heating (constant pressure), is compared to observations of flares in the extreme ultraviolet. In the range $T>10^5$ °K the temperature dependence of the emission measure for a typical subflare appears to agree with the impulsive heating model.

38365 Stability of the boundary layer of a skinned magnetic flux rope. Solov'ev, A.A. (Kalmyk State University, Elista). *Sov. Astron. Lett. (Engl. Transl.);* **3**: No. 4, 170-172(Jul 1977).

W. A. Newcomb's analysis of linear pinch stability implies that the boundary layer of a skinned magnetic rope, defined as the zone where the azimuthal field strength falls off more steeply than r^{-1}, is stable against small disturbances of arbitrary form.

GALAXIES

38366 Nature of the jet in M87. Shklovskii, I.S. (Shternberg Astronomical Institute, Moscow). *Sov. Astron. AJ (Engl. Transl.);* **21**: No. 4, 401-406(Jul 1977).

The jet in M87 is formed from magnetized plasma clouds with M≈1 M/sub sun/ extruded at relativistic velocities from the nucleus of this giant galaxy. The one-sided directionality of the jet is attributable to the relativistic Doppler effect. Energy and dynamical considerations yield estimates of 0".02-0".3 for the angular diameter of individual knots in the jet, and a value 1.5-2 for the parameter $\gamma=(1-\beta^2)$/sup -1/2/. The synchrotron spectrum of the jet is discussed. Deceleration of the knots by the surrounding plasma will evidently heat the intergalactic gas. Some general problems of activity in galaxy nuclei are considered in the light of the results obtained.

38367 Influence of dust on collisional pumping of an H_2O cosmic maser. Bolgova, G.T.; Strel'nitskii, V.S.; Shmeld, I.K. (Astronomical Council of the Academy of Sciences of the USSR). *Sov. Astron. AJ (Engl. Transl.);* **21**: No. 4, 468-471(Jul 1977).

A joint solution is obtained for the steady-state equations of the populations of 48 rotational levels of ortho-H_2O and for the equations of radiation transfer in the lines connecting these levels, with allowance for the absorption and emission of resonance photons by dust particles in the continuous spectrum. The radiation transfer was analyzed in a model of a homogeneous, isothermal, plane-parallel layer approximating the region of collisional pumping behind the front of the circumstellar shock wave. It is found that absorption and emission in the continuous spectrum can have a very strong effect on the character of the population distribution of the rotational levels. Depending on the ratio of the kinetic temperature T/sub k/ to the dust temperature T/sub d/ the "turning on" of the dust can either strongly increase the inversion of the 6_{16}-5_{23} transition along the entire layer (when T/sub d/very-much-less-thanT/sub h/) or, conversely, strongly reduce or entirely liquidate the inversion (when T/sub d/=T/sub h/). The removal of rotational photons on cold dust weakens the thermalizing effect of the multiple scattering of photons, restoring the inversion of many of the transitions resulting from collisional pumping.

38368 Construction of theoretical spectra for compact H ii zones. Tutukov, A.V.; Shustov, B.M. (Astronomical Council, USSR Academy of Sciences, Moscow). *Sov. Astron. Lett. (Engl. Transl.);* **3**: No. 4, 191-193(Jul 1977).

From simplified evolutionary models of compact H ii regions, theoretical spectra of the emergent radiation are constructed for frequencies from 10^7 to 10/sup 15.5/ Hz. These spectra comprise the thermal radiation of the H ii zone, the infrared radiation of the surrounding gas-dust envelope, and the radiation of the star itself, which penetrates the envelope at late phases in the development of the stellar cocoon. The spectra obtained in this manner are in qualitative accord with those observed for the compact H ii zone W3 (A).

COSMOLOGY

REFER ALSO TO CITATION(S) 38353

38369 Temperature fluctuations in the primordial background radiation due to gravitational waves. Doroshkevich, A.G.; Novikov, I.D.; Polnarev, A.G. (Institute of Applied Mathematics, USSR Academy of Sciences, Moscow). *Sov. Astron. AJ (Engl. Transl.);* **21**: No. 5, 529-535(Sep 1977).

The influence of cosmological gravitational waves on the anisotropy of the primordial microwave radiation is discussed. The calculations allow for the gradual rise in the transparency of the plasma to the primordial radiation as recombination proceeds at a red shift $z\approx1300$, for the curvature of three-space if $\Omega=$rho/rho/sub cr/ <1, and for the distorting effects of real antennas upon the observations. The results are presented in a form convenient for direct interpretation of the observations. Comparison of the theoretical results with the empirical evidence sets an upper limit on the possible energy density of gravitational waves in various parts of their spectrum. The anisotropy expected in the primordial electromagnetic radiation is calculated for various assumptions as to the cosmological gravitational wave spectrum.

38370 Recombination lines in the primordial radiation. Bernshtein, I.N.; Bernshtein, D.N.; Dubrovich, V.K. (Special Astrophysical Observatory, USSR Academy of Sciences). *Sov. Astron. AJ (Engl. Transl.);* **21**: No. 4, 409-413(Jul 1977).

An accurate numerical calculation is made for the intensity and profiles of hydrogen recombination lines of cosmological origin. The dependence of these quantities on parameters of matter in the universe is established: on the hydrogen density and on the total density of all kinds of matter.

38371 Distortion of the primordial radiation spectrum by the 21-cm hydrogen line at epochs $z=150$-15. Varshalovich, D.A.; Khersonskii, V.K. (Ioffe Physics and Technology Institute, USSR Academy of Sciences, Leningrad). *Sov. Astron. Lett. (Engl. Transl.);* **3**: No. 4, 155-156(Jul 1977).

A hydrogen absorption line will have developed in the primordial radiation spectrum because of the violation of local thermodynamic equilibrium during the adiabatic expansion of the universe at epochs z=150-15. The line profile is calculated; its depth and position of minimum depend essentially on the mean density Ω of matter in the universe and on the parameter z/sub e/, which specifies the epoch when the temperatures of radiation and matter were effectively decoupled. On this basis a method is proposed for determining Ω and z/sub e/.

38372 Prospects for determining the primordial abundances in the universe. Dubrovich, V.K. (Special Astrophysical Observatory, USSR Academy of Sciences, Zelenchukskaya). *Sov. Astron. Lett. (Engl. Transl.);* **3**: No. 4, 181-182(Jul 1977).

Estimates are obtained for the spectral distortions of the primordial background radiation in the 160-300 μ wavelength range that should result from the interaction of light elements of cosmological origin with hydrogen recombination photons. For lithium, in particular, the effect may amount to practically 100%.

38373 Dynamics of anisotropic homogeneous generalizations of the Friedmann cosmological models. Ruban, V.A. (Leningrad Institute for Nuclear Physics, USSR Academy of Sciences). *Sov. Phys. - JETP (Engl. Transl.);* **45**: No. 4, 629-637(Apr 1977).

The paper deals with the dynamics, particularly the character of the singularity and the process of isotropization of anisotropic cosmological models of the "diagonal" Bianchi types I, V, and IX (axially symmetric) filled with thermalized matter at rest with pressure P=nϵ (0/sup S/.n< or =1) and collisionless radiation (consisting of oppositely moving fluxes of ultrarelativistic free particles). The investigation is based on analytic solutions obtained in this paper. The latter are interpreted as perturbed flat, open or closed Friedmann metrios with infinitely (maximally in the type IX case) long gravitational waves against an isotropic background. The essential role of extremely "stiff" matter with an equation of state P=ϵ near the singularity is brought to light. This equation of state imitates the dynamical influence of a free (D'Alembertianpsi=0) scalar field psi=psi (tau). General relativistic analogs are indicated for the homogeneous vacuum solutions and anisotropic models for T for the scalar-tensor Dicke cosmology.

38374 Gravitational antenna with SQUID as sensor. Gusev, A.V.; Rudenko, V.N. (Moscow State University). *Sov. Phys. - JETP (Engl. Transl.);* **45**: No. 4, 637-644(Apr 1977).

A gravitational antenna with quantum magnetometer (SQUID) as sensor is considered. The factors that restrict the sensitivity of the SQUID in two regimes, without and with hysteresis, are analyzed. Expressions are obtained for the minimal detectable force connected with the intensity of gravitational radiation. Requirements are also formulated for the case of a sensor on an antenna with mechanical transformation of displacements.

38375 Photon condensation in an Einstein universe. Becker, J.D.; Castell, L. (Max-Planck-Institut zur Erforschung der Lebensbedingungen der Wissenschaftlich-Technischen Welt, Starnberg, Ger.). *Acta Phys. Austriaca, Suppl.;* No. 18, 885-897(1977).

From XVI proceedings on contacts between high energy physics and other fields of physics; Schladming, Austria (24 Feb 1977).

See CONF-770257—.

A model is given for the idea that matter arises from a condensation phenomenon. Starting with an Einstein universe with a metric arising from an initially unspecified isotropic matter density, it is assumed that a large number of free photons exists in this universe. The system of photons is treated with the usual methods of Bose—Einstein statistical mechanics, and results in a Bose—Einstein condensation, i.e., below a certain temperature T/sub c/ there is a photon liquid besides the usual photon gas. Next the matter in the universe is identified with this photon liquid. Then T/sub c/ can be calculated from the radius of the universe. The value T/sub c/ = 3.5 $(10)^{11}$K is found. The mass m/sub c/ = kT/c^2 associated with this temperature is m/sub c/ = 30 MeV. The condensation temperature T/sub c/ is expressed in terms of the radius of the universe, and the value N = 2.4 $(10)^{122}$ is found as well. 6 references (JFP)

PLANETARY PHENOMENA

38376 Electron cooling by excitation of carbon dioxide. Morrison, M.A.; Greene, A.E. (Theoretical Division T-12, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *J. Geophys. Res.;* **83**: No. A3, 1172-1174(1 Mar 1978).

The cooling of a heated electron gas by electron impact excitation of CO_2 is believed to be an important process in the neutral atmospheres of Mars and Venus. Electron energy loss rates are calculated for a variety of excitation processes as a function of electron temperature at a CO_2 gas temperature 0f 200 K. Vibrational excitation is found to be the most efficient cooling mechanism for the range of electron temperatures studied. The contributions of various vibrational energy loss processes to electron cooling are discussed.

ATOMIC, MOLECULAR, AND CHEMICAL PHYSICS

38377 (UCRL—80494) **Backward Raman gain and pulse compression of KrF laser radiation scattered by CH_4.** Murray, J.R.; Goldhar, J.; Szoeke, A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Dec 1977. Contract W-7405-ENG-48. 4p. (CONF-780510—6). Dep. NTIS, PC A02/MF A01.

From 10. quantum electronics conference; Atlanta, GA, USA (May 1978).

Backward Raman small signal gain and saturation measurements including linewidth and pressure dependences are presented for KrF laser radiation scattered by methane gas. The results are consistent with theoretical predictions.

38378 Ab initio calculations of the vertical electronic spectra of NO_2, NO^+_2, and NO^-_2. Benioff, P.A. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). *J. Chem. Phys.;* **68**: No. 8, 3405-3412(15 Apr 1978).

MCSCF/CI calculations of the vertical electronic spectra of NO_2, NO^+_2, and NO^-_2 were carried out at the NO_2 and NO^-_2 ground state experimental equilibrium conformations. These calculations extend previous calculations of the same type in that polarization functions are included in the basis set and various limitations on the number of open shells and on the number of configurations in the MCSCF and CI calculations are removed. Calculations were also carried out on NO^-_2 with a basis set augmented by diffuse s and p functions.

38379 Photoelectron spectrum of Xe_2 and potential energy curves for Xe^+_2. Dehmer, P.M.; Dehmer, J.L. (Argonne National Laboratory, Argonne, Illinois 60439). *J. Chem. Phys.;* **68**: No. 8, 3462-3470(15 Apr 1978).

The photoelectron spectrum of the Xe_2 van der Waals molecule was determined at 584 A with a resolution of 20 meV, using an apparatus which combines a supersonic molecular beam source with a hemispherical photoelectron spectrometer. This experiment gives new information on the potential energy curve for the bound Xe^+_2 ground state at large internuclear separation. An optimum potential was determined for this state by fitting the observed photoelectron peak to a calculated Franck-Condon distribution. The calculations show specifically that the Morse function is not an adequate approximation to the potential at large internuclear distances. This experiment also gives new information on the potential energy curves for the weakly bound Xe^+_2 excited states in the region of their potential minima, thus complementing Xe-Xe^+ scattering experiments which probe these potentials in the region of their repulsive walls. Potential energy curves for all of the Xe^+_2 states dissociating to $Xe(^1S_0)+Xe^+(^2P/sub\ 3/2/ or\ ^2P/sub\ 1/2/)$ are constructed primarily from experimental results and are compared with recent theoretical calculations by Wadt. Photoelectron spectra of heavier xenon clusters were also determined and are discussed briefly.

38380 Generalized finite polynomial approximation (WINIMAX) to the reduced partition function of isotopic molecules. Lee, M.W.; Bigeleisen, J. (Department of Chemistry, University of Rochester, Rochester, New York 14627). *J. Chem. Phys.;* **68**: No. 8, 3496-3500(15 Apr 1978).

The MINIMAX finite polynomial approximation to an arbitrary function has been generalized to include a weighting function (WINIMAX). It is suggested that an exponential is a reasonable weighting function for the logarithm of the reduced partition function of a harmonic oscillator. Comparison of the error function for finite orthogonal polynomial (FOP), MINIMAX, and WINIMAX expansions of the logarithm of the reduced vibrational partition function show WINIMAX to be the best of the three approximations. A condensed table of WINIMAX coefficients is presented. The FOP, MINIMAX, and WINIMAX approximations are compared with exact calculations of the logarithm of the reduced partition function ratios for isotopic substitution in H_2O, CH_4, CH_2O, C_2H_4, and C_2H_6 at 300 °K. Both deuterium and heavy atom isotope substitution are studied. Except for a third order expansion involving deuterium substitution, the WINIMAX method is superior to FOP and MINIMAX. At the level of a second order expansion WINIMAX approximations to ln(s/s')f are good to 2.5% and 6.5% for deuterium and heavy atom substitution, respectively.

38381 Approximation of isotopic reduced partition function ratios by the WINIMAX polynomial perturbation method (WIMPER). Bigeleisen, J.; Lee, M.W.; Ishida, T.; Bigeleisen, P.E. (Department of Chemistry, University of Rochester, Rochester, New York 14627). *J. Chem. Phys.;* **68**: No. 8, 3501-3510(15 Apr 1978).

Diagonal H, F, and G matrix approximations to the moments of the eigenvalues are studied for a number of polyatomic molecules. For molecules containing hydrogen atoms the diagonal element approximations to each of the first six moments do not differ from the true values by more than 15%. The results further substantiate the simplified method of analysis of the isotope chemistry of hydrogen in terms of stretching and bending forces. It is shown that the coupling of bending and stretching coordinates makes a significant contribution to the motion of "central" atoms in a molecule. Corrections to the reduced partition function ratios of isotopic molecules corresponding to uncoupled internal coordinates, the diagonal element approximation, are developed through the use of the WINIMAX polynomials (WIMPER). The magnitude of the corrections are related directly to the off-diagonal F and G matrix elements. Sample calculations show that the diagonal element approximations lead to values of ln (s/s')f for deuterium substitution within 1% of the exact values at 300°K. It is shown that the diagonal H and diagonal G-diagonal F approximations lead to values of ln(s/s/sup prime/)f which differ from exact values by 7% and 13%, respectively, at 300 °K for carbon and oxygen isotope substitutions. The second order correction $[(h/kT)^2]^2$ leads to approximations of ln(s/s')f within 3% of the exact values for carbon and oxygen isotope substitutions. Comparisons are made between the WIMPER method and the Singh-Wolfsberg perturbation method. Comparisons are also made between the WIMPER and the direct WINIMAX polynomial expansions of ln(s/s')f. The areas of physical significance of each of the methods is discussed.

38382 E1-M1 interference in radiative decay of hydrogenlike atoms in an electric field. Mohr, P.J. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Phys. Rev. Lett.;* **40**: No. 13, 854-856(27 Mar 1978).

An unpolarized hydrogenlike atom in the metastable 2S/sub 1/2/ state in an electric field decays primarily by one- or two-photon emission. The angular distribution of the single-photon radiation is expected to be asymmetric with respect to the electric field direction as a result of E1-M1 interference. Observable consequences of this effect in high-Z Lamb-shift experiments in progess are pointed out. A lowest-order estimate is given for the dependence of the asymmetry on the nuclear charge and the applied field strength.

38383 Effect of short-range Coulomb interaction on cooperative spontaneous emission. Coffey, B.; Friedberg, R. (Columbia University, New York, New York 10027). *Phys. Rev., A;* **17**: No. 3, 1033-1048(Mar 1978).

We follow in detail the spontaneous decay of fully excited samples of two and three resonant two-level atoms separated by distances much smaller than a wavelength. We include both the static dipole-dipole interaction and an intrinsic detuning (inhomogeneous broadening) of the atoms. We find that the Coulomb interaction may have both a decohering and a recohering effect. The decohering effect is seen in three atoms not equivalently placed. Here the Coulomb interaction diminishes super-radiance by subjecting the different atoms to different frequency shifts. The recohering effect is seen in all cases and consists in a protection of super-radiance against an inhomogeneous broadening far in excess of the inverse radiation time. Both effects have analogs in small many-atom samples studied in previous literature.

38384 Addendum: Systematics of moments of dipole oscillator-strength distributions for atoms in the first and second row. Inokuti, M.; Baer, T.; Dehmer, J.L. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., A;* **17**: No. 3, 1229-1231(Mar 1978).

The values of S(1) and L(1), i.e., quantities related to straggling of particles, given by Dehmer, Inokuti, and Saxon [Phys. Rev. A 12, 102 (1975)] are inaccurate within the Hartree-Slater model used in that work. Those values are too large by as much as several percent because of an overestimation of contributions from high excitation energies. Revised values of S(1) and L(1), accurate to about 1%, are presented and discussed in greater detail. They are now in closer agreement with other values of N, O, Ne, and Ar found in the literature. All the other S(μ) and L(μ) values given by Dehmer, Inokuti, and Saxon remain unchanged.

38385 (BNWL-tr—306) **Preparation of thin films by sputtering.** Reichelt, K. Translated from *Vak.-Tech.;* **24**: No. 1, 1-11(Feb 1975). 25p. Dep. NTIS, PC A02/MF A01.

Portions of document are illegible.

A review is presented of the preparation of thin films by sputtering methods. Part I reports on the physical bases and the technique of sputtering. Part II presents some examples of sputtering taken from the literature of the last few years.

BEAMS AND THEIR REACTIONS

38386 (COO—2326-27) **Li/Li_2 supersonic nozzle beam.** Wu, C.Y.R.; Crooks, J.B.; Yang, S.C.; Way, K.R.; Stwalley, W.C. (Iowa Univ., Iowa City (USA). Dept. of Chemistry). 1977. Contract EY-76-S-02-2326. 17p. Dep. NTIS, PC A02/MF A01.

The characterization of a lithium supersonic nozzle beam was made using spectroscopic techniques. It is found that at a stagnation pressure of 5.3 kPa (40 torr) and a nozzle throat diameter of 0.4 mm the ground state vibrational population of Li_2 can be described by a Boltzmann distribution with T/sub v/ = 195 +- 30°K. The rotational temperature is found to be T/sub r/ = 70 +- 20°K by band shape analysis. Measurements by quadrupole mass spectrometer indicates that approximately 10 mole per cent Li_2 dimers are formed at an oven body temperature of 1370°K n the supersonic nozzle expansion. This measured mole fraction is in good agreement with the existing dimerization theory.

38387 (LA-UR—78-429) **Hydriding of titanium cones for a sputter-ion source.** Gursky, J.C.; Sherwood, B.A. (Los Alamos Scientific Lab., N.Mex. (USA)). 1978. Contract W-7405-ENG-36. 6p. (CONF-771075—3). Dep. NTIS, PC A02/MF A01.

From 6. annual conference of the International Nuclear Target Development Society; Berkeley, CA, USA (19 Oct 1977).

A technique for producing negative ions of hydrogen, deuterium, tritium from a sputter-ion source by sputtering hydrided titanium in the source. The hydridation of the titanium is described. (GHT)

38388 Ion desorption by core-hole Auger decay. Knotek, M.L.; Feibelman, P.J. (Sandia Laboratories, Albuquerque, New Mexico 87185). *Phys. Rev. Lett.;* **40**: No. 14, 964-967(3 Apr 1978).

We present evidence for a fundamentally new mechanism for impact-induced desorption, viz., core-hole Auger decay. We thereby explain why observed thresholds for electron-stimulated desorption (ESD) of positive ions (O^+, OH^+, and F^+) from certain d-band metal oxides (TiO_2, V_2O_5, and WO_3) correlate in energy with the ionization potential of the highest-lying atomic core levels. We conclude that electron-stimulated desorption is in many interesting cases an atom-specific, valence-sensitive probe of surfaces.

ATOMIC AND MOLECULAR PROPERTIES

REFER ALSO TO CITATION(S) 37674

38389 (LA—7007-MS) **Thermodynamic properties of fluid n-D_2 in the 75 to 300 K and 2- to 20-kbar range.** Liebenberg, D.H.; Mills, R.L.; Bronson, J.C. (Los Alamos Scientific Lab., N.Mex. (USA)). Mar 1978. Contract W-7504-ENG-36. 24p. Dep. NTIS, PC A02/MF A01.

The hydrogen isotope deuterium is an important material for use in various energy technologies. This report is a summary of new pressure, volume, temperature, and sound velocity measurements of fluid n-D_2 in the 75 to 300 K and 2- to 20-kbar range. An equation of state (EOS) was fit to these data. The thermodynamic quantities, volume V, sound velocity v/sub s/, thermal expansivity α/sub p/, heat capacity at constant pressure C/sub p/, isothermal compressibility chi/sub T/, and molar entropy S, are given at 25°K and 0.5-kbar increments over the range of measurements. Computer-drawn graphs of the isothermal pressure variation of these quantities are shown. Characteristics of the EOS at high temperature and pressure are determined and compared with theoretical and phenomenological equations of state.

38390 Diatomic molecule vibrational potentials: Accuracy of representations. Engelke, R. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *J Chem. Phys.;* **68**: No. 8, 3514-3521(15 Apr 1978).

A method is presented for increasing the radius of convergence of certain representations of diatomic molecule vibrational potentials. The method relies on using knowledge of the analytic structure of such potentials to the maximum when attempting to approximate them. The known singular point (due to the centrifugal and/or Coulomb potentials) at zero internuclear separation should be included in its exact form in an approximate representation. The efficacy of this idea is tested [using Peek's "exact" numerical Born-Oppenheimer potential for the $(1s\sigma/sub\ g/)^2\Sigma^+/sub\ g/$ state of H^+_2 as a test problem] when the representational form is the series of (1) Dunham, (2) Simons, Parr, and Finlan, (3) Thakkar, and (4) Ogilvie-Tipping, and also (5) when the form is a [2, 2] or a [3, 3] Pade approximant. Significant improvements in accuracy are obtained in some of these cases, particularly on the inner wall of the potential. A comparison of the effectiveness of the five methods is made both with and without the origin behavior being included exactly. This is useful in itself as no comprehensive accuracy comparison of the standard representations seems to have appeared in the literature. The Ogilvie-Tipping series, corrected at the origin for singular behavior, is the best representation presently available for states analogous to the $(1s\sigma/sub\ g/)^2\Sigma^+/sub\ g/$ state of H^+_2.

38391 Relation between satellite peaks in x-ray emission and x-ray photoemission spectra. Martin, R.L.; Kowalczyk, S.P.; Shirley,

D.A. (Materials and Molecular Research Division, Lawrence Berkeley Laboratory and Department of Chemistry, University of California, Berkeley, California 94720). *J. Chem. Phys.;* **68**: No. 8, 3829-3836(15 Apr 1978).

A unified model is given to explain the satellite structures observed in x-ray emission spectroscopy (XES) and x-ray photoelectron spectroscopy (XPS) and the relationships between the two. This model accounts for electron correlation by the use of configuration interaction, rather than the heuristic "shake-up" approach, and actual eigenstates of the system are considered. Two situations are discussed, differing in whether the final XES states have holes in core or valence shells. For core-to-core XES transitions, the correlation-state structure is almost identical in initial and final states. Large satellite intensities may be observed in XPS, but not in XES, in accord with experiment. In core-to-valence XES transitions, the satellite structure should be similar to that observed in XPS, as observed. Detailed CI calculations for the 3s spectra of Ar are compared with measured spectra.

38392 Uncoupled symmetric stretching frequency of H_3^+. Dykstra, C.E.; Gaylord, A.S.; Gwinn, W.D.; Swope, W.C.; Schaefer, H.F. III. (School of Chemical Sciences, University of Illinois, Urbana, Illinois 61801). *J. Chem. Phys.;* **68**: No. 8, 3951-3952(15 Apr 1978).

The ab initio D/sub 3h/ potential energy surface for H_3^+ has been calculated using the method of self-consistent electron pairs (SCEP). The symmetric stretching frequency is estimated to be 3347.3 +- 0.5 cm^{-1} from these calculations.(AIP)

38393 First ionization potentials of lanthanides by laser spectroscopy. Worden, E.F.; Solarz, R.W.; Paisner, J.A.; Conway, J.G. (Lawrence Livermore Laboratory, Livermore, California 94550). *J. Opt. Soc. Am.;* **68**: No. 1, 52-61(Jan 1978).

Photoionization and Rydberg spectra of ten lanthanides have been studied using stepwise laser excitation and ionization methods. These spectra were obtained from several different laser populated excited states in each case. Accurate ionization limits were derived from observed photoionization thresholds. Except for praseodymium, the observation of one or more long Rydberg progressions allowed more accurate limits to be determined. The Rydberg convergence values in eV are Ce, 5.5387(4); Nd, 5.5250(6); Sm, 5.6437(6); Eu, 5.6704(3); Gd, 6.1502(6); Tb, 5.8639(6); Dy, 5.9390(6); Ho, 6.0216(6); and Er, 6.1077(10). For praseodymium a threshold value of 5.464(+12/sub -/2) eV was obtained. When plotted against N, the lanthanide ionization limits normalized to correspond to ionization from the lowest level of f/sup N/s^2 to the lowest level f/sup N/s form two straight lines connected at the half-filled shell.

38394 Experimental evidence for the existence of a Ramsauer—Townsend minimum in liquid CH_4 and Ar (Kr and Xe) and in gaseous C_2H_6 and C_3H_8. Christophorou, L.G.; McCorkle, D.L. (Oak Ridge National Lab., TN). *Can. J. Chem.;* **55**: 1876-1884(1977).

Experimental evidence for the existence of a Ramsauer—Townsend minimum in the electron scattering cross section for liquid CH_4 and liquid Ar (Kr and Xe) is presented and discussed. On the basis of evidence obtained from three sources: (1) comparisons of thermal electron mobilities in gases with those in liquids, (2) changes in the electron mobility with gas density at high and very high gas pressures, and (3) the dependence of the electron mobility on temperature for liquids whose V_0, the energy of the electron state in the liquid, is less than or equal to 0 eV, it is concluded that a Ramsauer—Townsend minimum is exhibited by the electron scattering cross section for CH_4, Ar (Kr and Xe) at all densities from a dilute gas to the liquid and that this minimum is shifted to lower energies (closer to thermal) with increasing density. Additionally, it has been found that a Ramsauer—Townsend-type behavior is exhibited by gaseous ethane (C_2H_6) and propane (C_3H_8) with the cross section minimum located at lower energies than for methane (CH_4). For these latter molecules the measured mean scattering cross sections at thermal energies are comparable with the geometric cross sections.

POSITRONIUM, MUONIUM, AND MUONIC AND MESIC ATOMS AND MOLECULES

REFER ALSO TO CITATION(S) 37688, 38472

38395 Muonic and hadronic atoms. Koch, H. (Univ., Karlsruhe, Ger.). pp 87-157 of Nuclear and particle physics at intermediate energies. Warren, J.B. (ed.). New York; Plenum Press (1976).

From Proceedings of the advanced study institute in nuclear and particle physics at intermediate energies; Victoria, B.C., Canada (Jun 1975).

See CONF-7506100—.

A rather self-consistent picture of the majority of experiments done thus far in the field of muonic and hadronic atoms is given in these lectures. Rather than a presentation of all available data, an explanation is given of selected experiments. Included are also some very recent ideas and experimental results. Properties of the muonic and hadronic atoms, the significance of measurements of energies, intensities, and the line shapes of x-ray transitions, the experimental set-up, measurable effects, and experimental test of parity violating character of neutral currents. 95 references. (JFP)

COLLISION PHENOMENA

38396 (LA-UR—78-649) **Detailed quantum transition state theory. Application to collinear reactions.** Walker, R.B. (Los Alamos Scientific Lab., N.Mex. (USA)). 1978. Contract W-7405-ENG-36. 48p. NTIS, MF A01.

Portions of document are illegible.

The applicability of the detailed quantum transition state theory (DQTST) of Light and Siczek (J. Chem. Phys. 64, 1907(1976)) is investigated for several collinear systems. The effects of boundary conditions and the placement of the transition state surface on the DQTST predictions are considered. It is shown that the reliability of DQTST is not simply correlated with any property of the reaction path profile (barrier height or reaction exothermicity): features of the potential energy surface associated with other degrees of freedom must also be considered.

38397 (LA-UR—78-934) **Quantum mechanics of electronic-rotational energy transfer in $F(^2P) + H_2$ collisions.** Wyatt, R.E.; Walker, R.B. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 50p. Dep. NTIS, PC A03/MF A01.

A theoretical study is made of electronic-rotational energy transfer in $F(^2P) + H_2$ three-dimensional collisions, with electronic matrix elements from DIM theory. The quantum close-coupled equations are integrated via the R-matrix propagation method. Inelastic quenching probabilities are emphasized, with and without simulated open reaction channels. Interweaving patterns in the transition probability for even and odd nuclear parity vs. J (total angular momentum quantum number) are analyzed in terms of avoided crossing structure in the electrotational energy correlation diagrams. Localized regions where electronic quenching is dominant are identified in the correlation diagrams, and are confirmed in separate calculations which neglect interchannel mixing in local regions of the atom-molecule separation. Open reaction channels are found to have little influence on the quenching probabilities in these low energy calculations.

38398 (ORO—4703-16) **Interaction of slow electrons with high-pressure gases ("quasi-liquids"); synthesis of our knowledge on slow electron-molecule interactions. Progress report, February 1, 1977—January 31, 1978.** Christophorou, L.G.; McCorkle, D.L.; Christodoulides, A.A.; Wang, H.T. (Tennessee Univ., Knoxville (USA). Dept. of Physics and Astronomy). 1978. Contract EY-76-S-05-4703. 17p. Dep. NTIS, PC A02/MF A01.

Efforts to relate knowledge on isolated molecules (low pressure gases) to that on liquids or solids are described. High pressure (300 to approximately 100,000 torr) electron swarm experiments are yielding the first information as to the effects of the density and nature of the environment on fundamental electron-molecule interaction processes at densities intermediate to those corresponding to low pressure gases and liquids, and the gradual transition from "isolated molecule" to "condensed phase" behavior. (GHT)

38399 Lifetime and quenching rate constants for Kr_2F^* and Kr_2^*. Quigley, G.P.; Hughes, W.M. (University of California, Los Alamos Scientific Laboratory, P.O. Box 1663, Los Alamos, New Mexico 87545). *Appl. Phys. Lett.;* **32**: No. 10, 649-651(15 May 1978).

A broadband 2.5-ns-long argon excimer photolytic source was used to initiate the reaction sequence resulting in the formation of Kr_2F^*. The resulting fluorescence signal at 400 nm depended on the radiative and quenching processes of Kr_2^* as well as Kr_2F^*. The radiative lifetime of Kr_2F^* was found to be 181 +- 12 ns. The rate constants for quenching by F_2 and Kr are 4.3 +- 0.4 x 10^{-10} and 6.9 +- 0.7 x 10^{-15} cm^3 s^{-1}, respectively. The Kr_2^* coupled l/sub u/, O/sub u/ lifetime is 280 +- 30 ns and the rate constant for quenching of Kr_2^* by F_2 is 2.1 +- 0.2 x 10^{-10} cm^3 s^{-1}.

38400 Energy transfer in atom-diatom collisions: Vibronic excitation. Kelley, J.D.; Bearman, G.H.; Harris, H.H.; Leventhal, J.J. (McDonnell Douglas Research Laboratories, St. Louis, Missouri 63166). *J. Chem. Phys.;* **68**: No. 8, 3345-3351(15 Apr 1978).

Product state distributions from charge-transfer collisions between Ar^+-N_2 and H^+-O_2 as well as collision-induced excitation involving N^+_2 on He, Ar, and Xe are presented. These data, obtained from collision-produced emission spectra, are compared with a Franck-Condon model for the excitation-radiation process; significant deviations are observed and explained on the basis of a qualitative curve-crossing model formulated to treat such vibronic excitation processes.

38401 Reactive and inelastic scattering of H_2+D_2 using a repulsive model potential energy surface. Brown, N.J.; Silver, D.M. (Department of Mechanical Engineering and Energy and Environment Division, Lawrence Berkeley Laboratory, Berkeley, California 94720). *J. Chem. Phys.;* **68**: No. 8, 3607-3617(15 Apr 1978).

Collisions between hydrogen and deuterium molecules are examined using quasiclassical dynamical trajectory calculations with the intermolecular field specified by a semiempirical potential-energy surface incorporating enough repulsive character to yield barriers to chemical exchange that are in general agreement with ab initio results. The trajectory calculations are performed at high total system energies to permit the possibility of reactions. In addition to nonreactive inelastic collisions, the reactants H_2+D_2 can produce four possible reactive cases with product species $2H+D_2$, H_2+2D, $HD+H+D$, and 2HD. The results are presented in terms of reaction probabilities, average final state properties of the molecules, and average final state energy distributions.

38402 XeO* production through collisional electronic energy transfer from two-photon excited Xe atoms. Kligler, D.; Pritchard, D.; Bischel, W.K.; Rhodes, C.K. (Molecular Physics Center, SRI International, Menlo Park, California 94025). *J. Appl. Phys.;* **49**: No. 4, 2219-2223(Apr 1978).

The observation of electronic energy transfer to $XeO(^1\Sigma^+)$ from xenon atoms excited by two-photon absorption is reported. Electronically excited xenon atoms in the $5p^56p$ configuration are produced through two-photon excitation at 248.4 nm (KrF^*). Subsequent energy transfer from excited rare-gas atoms to N_2O leads to the appearance of $XeO(^1\Sigma^+)$, which is identified by the detection of its characteristic green emission band. These measurements are in accord with estimates of the relevant two-photon amplitudes for Xe and N_2O. Kinetic studies utilizing these techniques provide a flexible method for the study of selective excitation and energy transfer in a wide class of atomic and molecular materials.

38403 Resonant coherent excitation of channeled ions. Datz, S.; Moak, C.D.; Crawford, O.H.; Krause, H.F.; Dittner, P.F.; Gomez del Campo, J.; Biggerstaff, J.A.; Miller, P.D.; Hvelplund, P.; Knudsen, H. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev. Lett.;* **40**: No. 13, 843-847(27 Mar 1978).

We have observed resonant excitation of swift channeled hydrogenlike ions ($Z = 5$ to $Z = 9$) and heliumlike F^{7+} which arises from a coherent periodic perturbation by the atoms in the bounding crystal rows. The resonance excitation was seen through the reduction in the transmission of fixed-charge-state ions through channels in thin crystals of Au and Ag.

38404 Single electron capture by multiply charged ^{28}Si ions in atomic and molecular hydrogen. Kim, H.J.; Phaneuf, R.A.; Meyer, F.W.; Stelson, P.H. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., A;* **17**: No. 3, 854-858(Mar 1978).

Cross sections for single electron capture by Si/sup q+/ ($2 < \text{or} = q < \text{or} = 9$) incident on atomic and molecular hydrogen have been measured in the relative-collision-velocity range (3.1-6.3) x 10^8 cm/s. All measured cross sections decrease monotonically with relative velocity and scale roughly as q/sup N/. The values of N needed to fit the data range from ~ 2 to ~ 3 and increase with velocity. Cross sections averaged over incident charge states q for molecular hydrogen are larger than for atomic hydrogen, becoming twice as large for relative velocities greater than 4 x 10^8 cm/s. For the limited cases where comparison was possible, we found the classical-trajectory Monte Carlo calculation to give a good account of the experimental results.

38405 Exchange in low-energy electron-molecule scattering: Free-electron-gas model exchange potentials and applications to e-H_2 and e-N_2 collisions. Morrison, M.A.; Collins, L.A. (Theoretical Division T-12 (MS 531), Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Phys. Rev., A;* **17**: No. 3, 918-938(Mar 1978).

Calculations of cross sections for elastic e-N_2 collisions have been performed for impact energies from 0.01 to 1.0 Ry using model exchange potentials based on a free-electron-gas approximation in order to evaluate the utility of such local potentials in low-energy electron-molecule scattering. A body-frame fixed-nuclei formulation of the collision problem is used which treats the molecule as rigid and does not allow for electronic or vibrational excitation. Coupled integrodifferential scattering equations which incorporate exchange rigorously are derived and the simplification of the nonlocal exchange potential to an approximate energy-dependent local potential is described. An initial study of e-H_2 collisions is reported in which results obtained with various model exchange potentials are compared to those of exact static-exchange calculations. Cross sections for the e-N_2 system obtained using the model exchange potentials (with and without polarization) are reported and compared with measured cross sections and the results of other theoretical studies. For both systems, good agreement with more rigorous treatments of exchange can be obtained.

38406 Scaling properties of the dielectronic recombination amplitudes. Retter, J.A.; Gau, J.N.; Hahn, Y. (Department of Physics, University of Connecticut, Storrs, Connecticut 06268). *Phys. Rev., A;* **17**: No. 3, 998-1006(Mar 1978).

The dielectronic recombination amplitude is given in the resonance approximation by a product of the radiationless capture amplitude S to one of the resonant intermediate states and the radiative decay amplitude R of that resonant state. For highly charged ionic targets, both S and R are expected to scale approximately in the nuclear core charge Z/sub C/ for each isoelectronic sequence, and we study the scaling property and its breaking as the number of electrons in the ion increases. The effects of Coulombic and exchange correlations as well as the relativistic correction are considered. Based on the explicit evaluation of the S and R amplitudes using Hartree-Fock wave functions, we have determined an effective scaling function, which has been used to predict the radiation and Auger-emission probabilities A/sub r/ and A/sub a/ for Ar, Mo, and W from the available values for Fe.

38407 Polarization effects in inelastic electron-atom collisions accompanied by a change in the atomic spin. Drukarev, G.F.; Ob"edkov, V.D. (Leningrad State University). *Sov. Phys. - JETP (Engl. Transl.);* **45**: No. 4, 686-689(Apr 1977).

A theoretical description is given of the polarization effects which occur in three-electron systems in collisions which give rise to singlet-triplet transitions in an atom. The operators of a transition are derived and these make it possible to calculate the polarization of all the electrons of the system as a result of excitation of the atom and a change in its spin by unity. The results of this calculation are in agreement with recent experimental data on the depolarization of electron beams caused by the excitation of triplet atomic states.

38408 Manifestation of the interference of quasimolecular states in radiation polarization when Ca^+, Sr^+, and Ba^+ ions collide with inert-gas atoms. Ovchinnikov, V.L.; Kharchenko, V.A.; Volovich, P.N.; Shpenik, O.B. (Uzhgorod State University). *Sov. Phys. - JETP (Engl. Transl.);* **45**: No. 4, 709-713(Apr 1977).

The energy dependences of the total cross sections for the excitation and polarization of the emission of the resonance lines in collisions of Ca^+, Sr^+, and Ba^+ ions with inert-gas atoms. It is established that the radiation is strongly polarized in the region of the threshold excitation energies. A new type of interference is observed, causing the experimentally observed oscillations of the polarization functions. A model is proposed for the explanation of the aggregate of the experimental data. Quantitative estimates are obtained of the frequency and amplitude of the oscillations; these estimates agree well with the experimental values.

ATOMIC AND MOLECULAR THEORY

38409 (UCRL—80093) Tunneling in network models of molecular chains. Budgor, A.B. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 Nov 1977. Contract W-7405-ENG-48. 26p. (CONF-771150—1). Dep. NTIS, PC A03/MF A01.

From Conference on tunneling in biological systems; Philadelphia, PA, USA (3 Nov 1977).

A network model of electrons as developed by Montroll is used to describe the high anisotropic conductivity of a certain class of molecular crystals. The molecular crystals are modeled as a one-dimensional chain of periodically spaced units of free electron paths separated by potential barriers. Since this anomalously high conductivity in a narrow temperature range seems to result from some subtle interplay between the lattice vibrations of the crystal and certain electron pathways between them, the energy band edges versus separation distance between benzene units is plotted for a model of TTF-TCNQ. Results seem to indicate that there exists critical separation distances between neighboring units in which a free electron tunneling passage way develops so that electron propagation through the chain becomes possible. 9 figures.

FLUID PHYSICS

REFER ALSO TO CITATION(S) 37815

GENERAL FLUID DYNAMICS

38410 (ANL—77-57) Efficient numerical scheme based on the method of characteristics applicable to two-dimensional fluid transients. Shin, Y.W.; Valentin, R.A. (Argonne National Lab., Ill. (USA)). Dec 1977. Contract W-31-109-ENG-38. 27p. Dep. NTIS, PC A03/MF A01.

Two-step explicit numerical procedures based on the method of characteristics are presented. These procedures use four bicharacteristics equally spaced on the Mach cone. The velocity

components are first obtained for the entire field by use of known initial data. Pressure is calculated in the second step in which the advanced velocity data are used. Nowhere in these procedures is an iterative scheme required. A linearized set of hyperbolic differential equations describing two-dimensional transients in slightly compressible fluid is considered for numerical solution. Detailed schemes are described in which all integration paths (bicharacteristics) remain in the coordinate planes; hence, only simple linear interpolation is required. These schemes allow time steps as large as the entire Courant step. Further, a stable new scheme is discussed in which the allowable time step can actually exceed the Courant time step. The procedure recommended for such computations was chosen after an extensive numerical experimentation that demonstrated its simplicity, efficiency, and accuracy. Exact analytical solutions are constructed and compared with numerical results to demonstrate the accuracy of the recommended scheme. 13 figures.

38411 Method of generalized coordinates and an application to Rayleigh-Taylor instability. Dienes, J.K. (Theoretical Division, Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Fluids;* **21**: No. 5, 736-744(May 1978).

The method of generalized coordinates is extended to the analysis of continuous bodies for which the degrees of freedom are independent velocity distributions in the spatial coordinates. The corresponding Lagrange equations contain generalized convective terms as well as the usual generalized forces and masses. Since the existence of a potential is not assumed, the equations of motion can be applied to media with arbitrary (possible dissipative) constitutive laws. Material deformation is characterized by the rate of strain, which is taken as the symmetric part of the velocity gradient, making the approach valid for arbitrarily large deformations. As an example, infinitesimal Rayleigh-Taylor instability is considered by analytic methods. Then, large amplitude Rayleigh-Taylor instability is represented with a single-degree-of-freedom analysis that shows the development (by numerical integration) of the known spike-and-bubble configuration of the unstable interface. The infinitesimal stability of a plastically deforming solid and the growth of the instability to large amplitudes are also considered.

38412 Interfacial stability with mass and heat transfer. Hsieh, D.Y. (Division of Applied Mathematics, Brown University, Providence, Rhode Island 02912). *Phys. Fluids;* **21**: No. 5, 745-748(May 1978).

A simplified formulation is presented to deal with interfacial stability problems with mass and heat transfer. For Rayleigh-Taylor stability problems of a liquid-vapor system, it is found that the effect of mass and heat transfer tends to enhance the stability of the system when the vapor is hotter than the liquid, although the classical stability criterion is still valid. For Kelvin-Helmholtz stability problems, however, the classical stability criterion is found to be substantially modified due to the effect of mass and heat transfer.

38413 Completion of the multi-point turbulent equations using an approximation to the mean value theorem. Fox, R.L. (Sandia Laboratories, Albuquerque, New Mexico 87115). *Phys. Fluids;* **21**: No. 5, 852-853(May 1978).

An approximation to the form of the multi-point interactions is combined with the mean value theorem and coincident properties of the distribution functions to produce a closed set of equations. The solution for isotropic flow is similar to that previously obtained by discarding three-point interactions.

38414 Aerosol impactors: A study of a fluid jet impinging upon a void. Forney, L.J.; Ravenhall, D.G.; Winn, D.S. (University of Illinois at Urbana-Champaign, Urbana, Illinois 61801). *J. Appl. Phys.;* **49**: No. 4, 2339-2345(Apr 1978).

The theoretical analysis of a two-dimensional jet of ideal fluid impinging normally upon a void has been made and compared with experimental observations. Using a scaled-up water model with a fixed-jet Reynolds number of 750, general features of the flow such as streamline positions and fluid velocities are in good agreement with theoretical predictions. Moreover, theoretical limitations on the void-space opening ratio h/w for a given jet spacing ratio s/w covering a range from 0 to 2 correlate well with the onset of irregularities in the observed flow pattern. Finally, experimental precautions are outlined necessary to minimize fluid instabilities and concurrent fluid flux into the void space.

38415 Segregation phenomenon in spouted beds. Piccinini, N. *Can. J. Chem. Eng.;* **55**: No. 2, 122-125(Apr 1977).

Preliminary experiments with spouted beds of binary mixtures of particles have shown that segregation according to size or density clearly occurs with heavier particles going to the upper inside part of the annulus. Segregation tendency becomes less pronounced with increasing gas flow rate. During continuous operation, the concentration of coarse particles in the discharge stream was found to be initially lower than in the feed, but it increased within 10-15 min to the feed concentration. The proportion of coarse particles in the bed always remained higher than in the solids leaving the bed.

38416 Movement of gas near a bubble in a coarse-particle fluidized bed. Livshits, Yu.E.; Tamarin, A.I.; Galershtein, D.M.; Shuklina, V.M. (Inst. of Heat and Mass Exchange, Minsk). *Vestsi Akad. Navuk BSSR, Ser. Fiz.-Energ. Navuk;* No. 1, 44-48(1977). (In Russian).

The gas velocity field around a bubble in a two-dimensional coarse-particle fluidized bed was measured by a DISA constant-temperature hotfilm anemometer and cinematography. The results are compared with those obtained by Davidson's model.

38417 Axial transfer of the solid phase in a fluidized bed. Tamarin, A.I.; Teplitskii, Yu.S. (Inst. of Heat and Mass Exchange, Minsk). *Vestsi Akad. Navuk BSSR, Ser. Fiz.-Energ. Navuk;* No. 1, 102-106(1977). (In Russian).

Based on the data for characteristics of gas bubbles and axial heat and solid phase transfer in fluidized beds, the correletion K = 0,1(H_0D/sub k/)/sup 1/2/(u-u_0)$Re^{-0.4}$ was proposed. D/sub k/ is the column diameter, H_0 the original height of the bed, u the filtration velocity, u_0 velocity of original fluidization.

MAGNETOHYDRODYNAMICS

38418 Three-dimensional magnetohydrodynamic turbulence in cylindrical geometry. Montgomery, D.; Turner, L.; Vahala, G. (Department of Physics and Astronomy, The University of Iowa, Iowa City, Iowa 52242). *Phys. Fluids;* **21**: No. 5, 757-764(May 1978).

Ideal magnetohydrodynamic turbulence is treated using more realistic boundary conditions than rectangular periodic boundary conditions. The dynamical equations of incompressible magnetohydrodynamics and the associated fields are expanded in a set of vector eigenfunctions of the curl. The individual eigenfunctions represent force-free fields, but superpositions of them do not. Three integral invariants have simple quadratic expressions in the expansion coefficients: the total energy, the magnetic helicity, and the cross helicity. The invariants remain temporally constant in the face of a truncation at a large but finite number of coefficients. Boundary conditions imposed are those for a rigid, perfectly-conducting cylindrical boundary, with an arbitrary periodicity length parallel to the axis. Canonical distributions are constructed from the invariants. Mean-square turbulent velocity fields $\langle v^2 \rangle$ have finite values for virtually all initial conditions, including quiescient ones. The stability problem can be reformulated as a search for values of the integral invariants which will minimize $\langle v^2 \rangle$. This leads to a principle of extremal helicity, which requires a magnetic configuration which will minimize $\langle v^2 \rangle$ for a given total energy. The development of helical macroscopic structures in the cylinder as a function of increasing ratio of axial current to axial magnetic flux is predicted.

SUPERFLUIDITY

REFER ALSO TO CITATION(S) 37662

38419 Tip-angle-dependent magnetic relaxation in superfluid ^{3}He. Webb, R.A. (Argonne National Laboratort, Argonne, Illinois 60439). *Phys. Rev. Lett.;* **40**: No. 13, 883-886(27 Mar 1978).

Using a pulsed superconducting-quantum-interference-device (SQUID) NMR technique, relaxation of the longitudinal magnetization in superfluid ^{3}He has been measured in magnetic fields of 31, 102, 180, and 306 Oe in the pressure range 16-26 bar. It is observed that in both superfluid phases there is a temperature-dependent, well-defined spin-tipping angle, θ/sub c/, for which the relaxation of the magnetization changes from an exponential to a nonexponential behavior.

38420 Phase transition of superfluid ^{3}He-B to an inhomogeneous state induced by an electric field. Gongadze, A.D.; Gurgenishvili, G.E.; Kharadze, G.A. (Institute of Physics, Georgian Academy of Sciences). *Sov. Phys. - JETP (Engl. Transl.);* **45**: No. 4, 805-808(Apr 1977).

The combined effect of electric and magnetic fields on the orientation of the anisotropy axis of superfluid B-phase liquid ^{3}He located in a gap between two parallel plates is considered. The configuration is analyzed for the case in which E and H are parallel and directed perpendicularly to the plane surface. It is shown that the superfluid B-phase undergoes a phase transition to an inhomogeneous state at a certain critical electric field intensity E/sub c/. The E/sub c/ depends on the gap width, the magnetic field intensity, and the temperature.

HIGH ENERGY PHYSICS

38421 Nuclear and particle physics at intermediate energies. Warren, J.B. (ed.). New York; Plenum Press (1976). 616p. (CONF-7506100—).

From Proceedings of the advanced study institute in nuclear and particle physics at intermediate energies; Victoria, B.C., Canada (Jun 1975).

The conference contained 19 papers. Separate abstracts were prepared for 17 papers. Two papers appeared previously in ERA having conference numbers: CONF 7506100-1 and CONF 7506100—2. (JFP)

PARTICLE INTERACTIONS AND PROPERTIES - EXPERIMENTAL

38422 (UCR—34-P107-220) Annual report [on high energy physics research], January 1, 1977—November 30, 1977. Kernan, A.; Poe, R.T. (California Univ., Riverside (USA)). Dec 1977. Contract EY-76-S-03-0034-107. 22p. Dep. NTIS, PC A02/MF A01.

Progress is reported for experimental research in high energy physics at the University of California at Riverside. (SDF)

38423 Particle Data Group: using a GDMS to solve data handling problems in particle physics. Stevens, P.R. (California Inst. of Tech., Pasadena); Rittenberg, A. pp 173-179 of Generalized data management systems and scientific information. Paris; OECD Nuclear Energy Agency (1978).

From OECD/NEA working group on nuclear information; Berkeley, CA, USA (5 Oct 1977).

See CONF-771062—.

Data handling needs and problems in particle physics are examined. Three different approaches at resolving these problems are discussed with emphasis on the efforts of the Particle Data Group and on the role of GDMS in the solutions. 1 table.

38424 Use of a GDMS for high-energy reaction data. Moorhead, W.G. (CERN, Geneva). pp 180-183 of Generalized data management systems and scientific information. Paris; OECD Nuclear Energy Agency (1978).

From OECD/NEA working group on nuclear information; Berkeley, CA, USA (5 Oct 1977).

See CONF-771062—.

At CERN, data on high-energy reactions is being compiled by use of a Generalized Data Management System (GDMS). The GDMS is a stand-alone system designed for administrative and engineering applications. The data base at present contains about 20,000 cross-section values, each linked to a description of the corresponding reaction and the publication from which the value was derived. The immediate objective is to produce the widely circulated Compilation Reports, and the standard Report Generator of the GDMS is being used for this. Direct retrieval is also possible. 1 figure.

ELECTROMAGNETIC INTERACTIONS

38425 New measurement of the magnetic moment of the neutron. Greene, G.L.; Ramsey, N.F. (Harvard Univ., Cambridge, Mass. (USA)); Mampe, W. (Institut Max von Laue - Paul Langevin, 38 - Grenoble (France)); Pendlebury, J.M.; Smith, K. (Sussex Univ., Brighton (UK)); Dress, W.D.; Miller, P.D. (Oak Ridge National Lab., Tenn. (USA)); Perrin, P. (CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France)). *Phys. Lett., B;* **71**: No. 2, 297-300(21 Nov 1977).

The magnetic moment of the neutron has been measured with a factor of one hundred improvement in accuracy. In terms of the Bohr magneton and proton magnetic moment, respectively, the result is μsub(n)/μsub(B)=-1.04187579 (26) X 10^{-3}, μsub(n)/μsub(p)=-0.68497945 (17).

38426 Recent muon physics at SREL. Kane, J.R. (Coll. of William and Mary, Williamsburg, VA). pp 45-57 of Nuclear and particle physics at intermediate energies. Warren, J.B. (ed.). New York; Plenum Press (1976).

From Proceedings of the advanced study institute in nuclear and particle physics at intermediate energies; Victoria, B.C., Canada (Jun 1975).

See CONF-7506100—.

A description is given of current and future activity in the muon program at SREL. Included are quantum electrodynamics, V—A weak interactions, nuclear charge structure, μ^+ solid state studies, weak neutral currents, and the lepton conservation law. 17 references. (JFP)

WEAK INTERACTIONS

REFER ALSO TO CITATION(S) 38462

38427 Inclusive muon production in e^+e^- annihilation with < s/sup 1/2/> = 7.3 GeV. Badtke, D.H.; Barnett, B.A.; Jones, L.H.; Zorn, G.T.; Cavalli-Sforza, M.; Goggi, G.; Impellizzeri, F.S.; Livan, M.M.; Pastore, F.; Rossini, B.; Aschman, D.G.; Coyne, D.G.; Groom, D.E.; O'Neill, G.K.; Sadrozinski, H.F.W.; Shinsky, K.A.; Keller, L.P. (University of Maryland, College Park, Maryland 20742). *Phys. Rev. Lett.;* **40**: No. 13, 827-830(27 Mar 1978).

We present reslts on charged multiplicity n/sub ch/ = 2 and n/sub ch/ > 2 muon events produced in e^+e^- collisions with < s/sup 1/2/ > = 7.3 GeV at 90° to the beams. The background-subtracted inclusive cross section for the n/sub ch/ = 2 events is 10.2 +- 5.4 pb/sr, in agreement with the expected contribution from the heavy lepton tau. The cross section for the n/sub ch/ > 2 events is 19.0 +- 6.5 pb/sr whereas we expect only 2.9 pb/sr from the tau, indicating that we may be seeing the weak decays of charmed mesons.

38428 Production of muon pairs in K°/sub L/-Cu interactions. Faessler, M.; Kirkby, J.; Liu, J.; Wojcicki, S.; Burns, R.; Condon, P.; Cowell, P. (Stanford Linear Accelerator Center). *Phys. Rev., D;* **17**: No. 3, 689-702(1 Feb 1978).

The di-muon production mass spectrum has been measured with a beam of 4-20-GeVc K°/sub L/'s incident on a copper target. The production of $\mu^+\mu^-$ pairs resulting from the decay of vector mesons (rho, ω, and phi) was observed with a cross section of 55 +- 10 nb per nucleon for x/sub F/ > 0.25 based on a specific production model. In addition we measured upper limits for $\mu^+\mu^-$ pair production cross sections with x/sub F/ > 0.25 of 20 nb per nucleon for m/sub mumu/ < 0.5 $GeVc^2$ and 35 nb per nucleon at the psi (3100).

STRONG BARYON-INDUCED INTERACTIONS

REFER ALSO TO CITATION(S) 38462, 38528

38429 Comparison of high-transverse-momentum π^0 production from π^-, K^-, p, and p beams. Donaldson, G.; Gordon, H.; Lai, K.; Stumer, I.; Barnes, A.V.; Mellema, D.J.; Tollestrup, A.V.; Walker, R.L.; Dahl, O.I.; Johnson, R.A.; Ogawa, A.; Pripstein, M.; Shannon, S. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev. Lett.;* **40**: No. 14, 917-920(3 Apr 1978).

We compare high-transverse-momentum (P/sub perpendicular/) inclusive π^0 production from π^-, K^-, p, and p beams, at 100 and 200 GeV/c, for center-of-mass (c.m.) angles ranging from 2° to 115°, and P/sub perpendicular/ < 4.5 GeV/c. The ratio σ ($pp \to \pi^0X$)/σ ($\pi p \to \pi^0X$) decreases with increasing P/sub perpendicular/, and changes dramatically with c.m. angle. Also, the ratios σ ($K^-p \to \pi^0X$)/σ ($\pi^-p \to \pi^0X$) and σ ($pp \to \pi^0X$)/σ ($pp \to {}^0X$) are approximately constant. The measurements are consistent with a theoretical viewpoint in which constituents of the incident hadrons undergo a hard-scattering subprocess.

38430 Line-reversal comparison of $pp \to \pi^+\pi^-$ and $\pi^-p \to p\pi^-$ at 6 GeV/c. Sharfman, N.; Bar-Yam, Z.; Dowd, J.P.; Kern, W.; Russell, J.J.; Singer, M.N.; Edelstein, R.M.; Green, D.R.; Halpern, H.J.; Makuchowski, E.J.; Russ, J.S.; Stein, N.A. (Southeastern Massachusetts University, North Dartmouth, Massachusetts 02747). *Phys. Rev. Lett.;* **40**: No. 11, 681-684(13 Mar 1978).

We present differential cross sections at 6 GeV/c for the baryon-exchange reactions (1) $pp \to \pi^+\pi^-$ and (2) $\pi^-p \to p\pi^-$ over the range -t/sub min/ < -t < 1.5 GeV^2. Unlike previous experiments at similar momenta, our results are consistent with line-reversal symmetry for -t < 1.0 GeV^2. We contrast this to our previous results on (3) $pp \to \pi^-\pi^+$ and (4) $\pi^+p \to p\pi^+$ for which line-reversal symmetry is not satisfied.

38431 Quasielastic charge exchange in $n^2H \to pnn$ at 794 MeV. Bonner, B.E.; Simmons, J.E.; Wallace, J.M.; Evans, M.L.; Glass, G.; Hiebert, J.C.; Jain, M.; Northcliffe, L.C.; Bjork, C.W.; Riley, P.J.; Cassapakis, C.G. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Rev., C;* **17**: No. 2, 664-670(Feb 1978).

The proton spectrum resulting from 794-MeV neutron bombardment of deuterium was measured at several angles. The angular distribution of the integral of the quasielastic charge exchange peak is fitted very well by the two exponential form dt/dt = α_1e/sup β// sup t/ + α_2e/sup beta2t/ as has previously been found for the np elastic case. The ratio of the two cross sections at t = 0 is 0.56 +- 0.04. A modified impulse approximation calculation accounts for most features of the observed angular distribution.

38432 Extreme back angle n^2H elastic scattering at 794 MeV. Bonner, B.E.; Simmons, J.E.; Evans, M.L.; Glass, G.; Hiebert, J.C.;

Jain, M.; Northcliffe, L.C.; Bjork, C.W.; Riley, P.J.; Cassapakis, C.G. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Rev., C;* **17**: No. 2, 671-675(Feb 1978).

The cross section for elastic scattering of 794-MeV neutrons by deuterium has been measured for neutron center of mass angles from 139/sub D/ to 179/sub D/. The angular distribution is fitted very well both by an empirical function αe/sup β/(u-u180D)/sup / and by a calculation that uses the one parameter Craigie-Wilkin triangle diagram technique.

38433 Some recent polarized proton beam experiments at the Argonne National Laboratory Zero Gradient Synchrotron. Swallow, E.C. (Univ. of Chicago). pp 573-589 of Nuclear and particle physics at intermediate energies. Warren, J.B. (ed.). New York; Plenum Press (1976).

From Proceedings of the advanced study institute in nuclear and particle physics at intermediate energies; Victoria, B.C., Canada (Jun 1975).

See CONF-7506100—.

The discussion of recent polarized proton beam experiments includes the ZGS polarized beam and experimental program, the polarization parameter in p-n elastic scattering, parity violation in proton scattering, polarization parameter in small-angle p-p elastic scattering, and polarization effects in inclusive Λ production. 26 references. (JFP)

STRONG MESON-INDUCED INTERACTIONS

REFER ALSO TO CITATION(S) 38462, 38464

38434 (COO—1545-224) **Spectrometer study of $\pi^+\pi^-\pi^0$ and eta $\pi^+\pi^-$.** Edwards, K.W.; Legacey, D.; Brockman, P. (Carleton Univ., Ottawa, Ontario (Canada); McGill Univ., Montreal, Quebec (Canada); Ohio State Univ., Columbus (USA); Toronto Univ., Ontario (Canada)). 1977. Contract EY-76-C-02-1545. 15p. (CONF-7705117—1). Dep. NTIS, PC A02/MF A01.

From 5. conference on meson spectroscopy; Boston, MA, USA (May 1977).

The reaction $\pi^- p \to \pi^+\pi^-\gamma\gamma n$ is studied with high statistics at 8.5 GeV with a charged and neutral particle spectrometer. Both charged pions and both γ's are detected. A search was made for the $\pi^+\pi^-\pi^0$ decays of the neutral A_1 and the two missing isoscalar companions of the B, and are seeking to clarify the status of the D and E mesons in $\pi^+\pi^-$eta.

38435 Polarization measurement of the Σ^+ produced in the line-reversed reactions $\pi^+ p \to K^+\Sigma^+$ and $K^- p \to \pi^-\Sigma^+$ at 7 and 11.6 GeV/c. Baker, P.A.; Chima, J.S.; Dornan, P.J.; Gibbs, D.J.; Hall, G.; Miller, D.B.; Virdee, T.S.; White, A.P.; Ballam, J.; Bouchez, J.; Carroll, J.T.; Cautis, C.V.; Chadwick, G.B.; Chaloupka, V.; Field, R.C.; Frettag, D.R.; Lewis, R.A.; Minard, M.N.; Moffeit, K.C.; Stevens, R.A. (The Blackett Laboratory, Imperial College, London SW7 2AZ, Great Britain). *Phys. Rev. Lett.;* **40**: No. 11, 678-681(13 Mar 1978).

The polarization of the Σ^+ has been measured for the line-reversed reactions $\pi^+ p \to K^+\Sigma^+$ and $K^- p \to \pi^-\Sigma^+$ at 7 and 11.6 GeV/c using the SLAC Hybrid Facility. Since the Σ^+ decay is observed in the bubble chamber, the trigger of the flash lamps on a fast $K^+(\pi^+)$ did not bias the polarization measurements. We find that the Σ^+ polarizations from the two reactions have opposite signs but similar magnitude and are in much better agreement with the predictions of weak exchange degeneracy than previous lower-energy comparisons.

38436 Inclusive eta production at large transverse momenta. Donaldson, G.J.; Gordon, H.A.; Lai, K.; Stumer, I.; Barnes, A.V.; Mellema, D.J.; Tollestrup, A.V.; Walker, R.L.; Dahl, O.; Johnson, R.; Ogawa, A.; Pripstein, M.; Shannon, S. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev. Lett.;* **40**: No. 11, 684-687(13 Mar 1978).

We have measured the ratio of inclusive production of eta to π^0 at transverse momenta above 1.5 GeV/c. Results are presented for various meson and proton beams with momenta of 100, 200, and 300 GeV/c incident upon a hydrogen target. The eta/π^0 production ratio is found to be independent of incident beam momentum and of the transverse and longitudinal momenta of production. The ratio for pion- and proton-induced reactions is 0.44 +- 0.05; for kaons, it is 0.74 +- 0.12.

38437 Charged-K* (890) production at 13 GeV/c. Estabrooks, P.; Carnegie, R.K.; Brandenburgh, G.W.; Cashmore, R.J.; Davier, M.; Dunwoodie, W.M.; Lasinski, T.A.; Leith, D.W.G.S.; Matthews, J.A.J.; Walden, P. (McGill University, Montreal, Canada). *Phys. Rev., D;* **17**: No. 3, 658-668(1 Feb 1978).

We present high-statistics data on differential cross sections and density matrix elements for K^{+-}/sup()production obtained in a 13-GeV/c SLAC experiment. The most remarkable features of the data are the dominance of natural-parity exchange and significant differences between K^+ and K^- production by natural-parity isoscalar exchange. We present two exchange models which successfully describe this difference, as well as the overall t dependence: model A including Pomeron plus strongly exchange-degenerate Regge poles and model B involving broken exchange degeneracy for the f and ω exchanges. These two phenomenological models lead to different predictions for the energy dependence of K^{+-} production, for the relative K(1420)/K(890) production rate, and for the SU(3) - related rho^{+-} production processes.

38438 Inclusive neutral-strange-particle production in $\pi^- p$ interactions at 15 GeV/c. Barreiro, F.; Benary, O.; Brau, J.E.; Grunhaus, J.; Hafen, E.S.; Hulsizer, R.I.; Karshon, U.; Kistiakowsky, V.; Lainis, T.; Levy, A.; Miller, P.A.; Napier, A.; Pless, I.A.; Silverman, J.P.; Trepagnier, P.C.; Wolfson, J.; Yamamoto, R.K. (Laboratory for Nuclear Science, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Rev., D;* **17**: No. 3, 669-680(1 Feb 1978).

A study of the inclusive production of K°/sub S/, Λ, and Lambda-bar in $\pi^- p$ interactions at 15 GeV/c is presented. Inclusive cross sections for single neutral strange particles and neutral-strange-particle pairs are given. Longitudinal- and transverse-momentum distributions of the produced particles are presented. The average charged multiplicities of the systems recoiling against the Λ and the K°/sub S/ are compared and the results analyzed in the framework of a simple model. The Λ polarization is found to be in good agreement with Λ production from other strangeness-nonannihilating processes. Production of Λ's in the target fragmentation region is studied in the framework of the triple-Regge-pole-exchange model. The cross section for inclusive $K^+(890)$ production has been measured as 195 +- 35 μb, and the $\Sigma^+(1385)$ inclusive cross section has been found to be 174 +- 25 μb. The $K^+(890)$ and $\Sigma^+(1385)$ differential cross sections as functions of rapidity and transverse momentum are presented and discussed.

38439 Inclusive $\Delta^{++}(1232)$ production in $\pi^- p$ interactions at 15 GeV/c. Barreiro, F.; Benary, O.; Brau, J.E.; Grunhaus, J.; Hafen, E.S.; Hulsizer, R.I.; Karshon, U.; Kistiakowsky, V.; Levy, A.; Napier, A.; Pless, I.A.; Silverman, J.P.; Trepagnier, P.C.; Wolfson, J.; Yamamoto, R.K. (Laboratory for Nuclear Science, Massachusetts Institute of Technology, Canbridge, Massachusetts 02139). *Phys. Rev., D;* **17**: No. 3, 681-688(1 Feb 1978).

We present in this paper a study of the $\Delta^{++}(1232)$ inclusive production for momentum transfer squared to the target proton, vertical-bartvertical-bar < 1 $(GeV/c)^2$. We have investigated the production mechanism of the Δ^{++} by measuring its density matrix elements as a function of t and of the missing mass squared, M/sub X/^{2}, and by carrying out a triple-Regge analysis. For vertical-bartvertical-bar < 0.4 $(GeV/c)^2$, the Δ^{++} production mechanism is consistent with one-pion exchange. We have also studied the average charged multiplicity recoiling from the Δ^{++} as a function of M/sub X/^{2}, for vertical-bartvertical-bar < 0.4 $(GeV/c)^2$. The study yields information about the $\pi^-\pi^-$ average charged multiplicity.

38440 Measurements of polarization in $K^- p$ elastic scattering at low energies. Ehrlich, R.D.; Lovett, B.; Mishina, M.; Souder, P.A.; Snyder, J.; Zeller, M.E. (Yale Univ., New Haven, Conn. (USA). Dept. of Physics); Lazarus, D.M. (Brookhaven National Lab., Upton, N.Y. (USA)); Nakano, I. (Kyoto Univ. (Japan). Dept. of Physics). *Phys. Lett., B;* **71**: No. 2, 455-459(21 Nov 1977).

The polarization parameter has been measured in $K^- p$ elastic scattering at eight incident beam momenta between 650 MeV/c and 1071 MeV/c throughout a center of mass angular range of $-0.75 <$ costheta* < 0.85. Experimental results and coefficients of Legendre polynomial fits to the data are presented and compared with other measurements and partial wave analyses.

38441 Backward scattering of pions by nucleons. Lyubimov, V.A. (Institute of Theoretical and Experimental Physics, Moscow). *Sov. Phys. - Usp. (Engl. Transl.);* **20**: No. 9, 691-702(Sep 1977).

Backward elastic scattering of pions by nucleons is an elementary form of excitation with baryon exchange. The backward scattering cross section is very small and decreases rapidly with increasing energy. The cross section becomes maximal when the scattering angle approaches 180°, i.e., a peak is observed in the backward scattering. In contrast to forward scattering, in backward scattering the processes in which positive and negative pions participate are not similar. This is confirmed by the exchange character of the backward scattering. In the energy interval up to 5 GeV, backward scattering has an extremely pronounced resonant character, due to the influence of the s-channel baryon resonances. Experimental data on backward scattering in the intermediate energy region (up to 20 GeV) are satisfactorily described by the Regge theory of complex angular momenta. The energy dependence of the cross section agrees with the model with linear baryon trajectories. In the Serpukhov-accelerator energy range (20-40 GeV), however, a weakening of the energy dependence is observed in the backward $\pi^- n$ scattering. It is difficult to reconcile this behavior within the frame-

work of the Regge phenomenology, with the linear form of the nucleon trajectory. A phenomenon that has a bearing on the observed behavior of the backward scattering at high energies was unexpectedly observed in an entirelydifferent region. A phase-shift analysis of πN scattering at low energies (to 1 GeV) has shown that one of the partial waves (corresponding to the quantum numbers of the nucleon) experiences an appreciable rise when the energy approaches zero. It turns out that this singularity can be connected with the asymptotic behavior of the backward scattering. The two phenomena indicate that the effective spin of the nucleon reggeon greatly exceeds the value that follows from the linearity of the nucleon trajectory.

PARTICLE INTERACTIONS AND PROPERTIES - THEORETICAL

GENERAL

38442 Gauge-fixing degeneracies and confinement in non-Abelian gauge theories. Bender, C.M.; Eguchi, T.; Pagels, H. (Department of Physics, Washington University, St. Louis, Missouri 63130). *Phys. Rev., D;* **17**: No. 4, 1086-1096(15 Feb 1978).

Following several suggestions of Gribov we have examined the problem of gauge-fixing degeneracies in non-Abelian gauge theories. First we modify the usual Faddeev-Popov prescription to take gauge-fixing degeneracies into account. We obtain a formal expression for the generating functional which is invariant under finite gauge transformations and which counts gauge-equivalent orbits only once. Next we examine the instantaneous Coulomb interaction in the canonical formalism with the Coulomb-gauge condition. We find that the spectrum of the Coulomb Green's function in an external monopole-like field configuration has an accumulation of negative-energy bound states at E = 0. Using semiclassical methods we show that this accumulation phenomenon, which is closely linked with gauge-fixing degeneracies, modifies the usual Coulomb propagator form vertical-barkvertical-bar^{-2} to vertical-barkvertical-bar^{-4} for small vertical-barkvertical-bar. This confinement behavior depends only on the long-range behavior of the field configuration. We thereby demonstrate the conjectured confinement property of non-Abelian gauge theories in the Coulomb gauge.

38443 Rotationally invariant approximation to charge-monopole scattering. Balachandran, A.P.; Borchardt, S.; Chang, S.S.; Stern, A.; Cahalan, R.; Ramachandran, R.; Rupertsberger, H. (Physics Department, Syracuse University, Syracuse, New York 13210). *Phys. Rev., D;* **17**: No. 4, 1136-1149(15 Feb 1978).

A semiclassical approximation derived directly from the Feynman path integral is employed in the study of electric-charge-magnetic-monopole scattering. We show that this approximation, unlike perturbation theory, is consistent with rotational invariance. The semiclassical cross section is explicitly evaluated. It differs from the classical differential cross section for sufficiently large scattering angles due to the interference between the several classical trajectories contributing to the scattering at such angles. It is found that when the scattering angle is not too near the backward direction the semiclassical cross section approaches the classical limit rather slowly as the Dirac quantization number becomes large, or equally as h $\rightarrow$ 0 with the product of electric and magnetic charges held fixed.

38444 Asymptotic evaluation of cross sections by functional integration methods. Suranyi, P. (Department of Physics, University of Cincinnati, Cincinnati, Ohio 45221). *Phys. Rev., D;* **17**: No. 4, 1160-1171(15 Feb 1978).

It is shown that high-energy inclusive and semi-inclusive cross sections can be calculated directly from field theories using functional integration techniques. The cross sections are related to certain classical solutions of the field equations. A single solution of the field equations satisfying all constraints was found when the method was applied to a phi^4 quantum field theory. This solution gives an inclusive cross section with Feynman scaling and a reasonable transverse-momentum distribution in the semiclassical approximation.

38445 Average multiplicities in associated production. DeTar, C.E. (Center for Theoretical Physics, Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Rev., D;* **17**: No. 3, 870-873(1 Feb 1978).

For the inclusive reaction a + b $\rightarrow$ c + X it is predicted in various models that under certain general conditions the average multiplicity of particles of any type contained in X is of the form $\langle n \rangle = A + B \ln M^2$ where M^2 is the squared invariant mass of X. This prediction is discussed in a straightforward application of the Mueller-Regge model, and a scaling form for the dependence of A upon the invariants s and M^2 is noted.

38446 Pomeron-f identity and vector meson production. Duke, D.W. (Fermi National Accelerator Lab., Batavia, Ill. (USA)). *Phys. Lett., B;* **71**: No. 2, 342-344(21 Nov 1977).

The Pomeron-f identity scheme proposed by Chew and Rosenzweig is shown to fail badly when compared to vector meson production data. In contrast, a standard exchange degenerate ω-f model is satisfactory.

38447 Quarkonium level spacings. Quigg, C.; Rosner, J.L. (Fermi National Accelerator Lab., Batavia, Ill. (USA)). *Phys. Lett., B;* **71**: No. 1, 153-157(7 Nov 1977).

Motivated by the apparent equal spacing M(UPSILON')-M(UPSILON) = M(psi')-M(psi), the authors show that the potential for which quarkonium level spacings are independent of quark mass, in the nonrelativistic limit, is V(r) = Cln(r/r$_0$). Consequences of the logarithmic potential are enumerated and an alternative interpretation of the data is presented.

38448 Contacts between high energy physics and other fields of physics. Urban, P. (ed.). Vienna; Springer-Verlag (1977). 902p. (CONF-770257—). New York, NY.

From XVI proceedings on contacts between high energy physics and other fields of physics; Schladming, Austria (24 Feb 1977).

The conference contained 20 papers. Separate abstracts were prepared for 19 papers. One paper was outside the scope of ERA. (JFP)

ELECTROMAGNETIC INTERACTIONS

REFER ALSO TO CITATION(S) 38375, 38461

38449 Photoproduction of charged intermediate vector bosons. Mikaelian, K.O. (Fermi National Accelerator Laboratory Batavia, Illinois 60510). *Phys. Rev., D;* **17**: No. 3, 750-754(1 Feb 1978).

We consider the photoproduction of charged intermediate vector bosons W^+ or W^- with an arbitrary anomalous magnetic moment κe2M/sub W/. The cross sections at high energies are shown to increase logarithmically with sM/sub W/^{2} except for the case κ = 1, where a constant cross section equal to $\sqrt{2}\alpha$ G/sub F/ is reached. The deep-inelastic photoproduction of W^{+-} is calculated in a quark-parton model and we present numerical results for the total and the differential cross sections.

38450 psi phenomenology and the nature of quark confinement. Machacek, M.; Tomozawa, Y. (Randall Laboratory of Physics, University of Michigan, Ann Arbor, Michigan 48109). *Ann. Phys. (N.Y.);* **110**: No. 2, 407-420(Feb 1978).

The nonrelativistic Schroedinger equation is used with confinement potentials that are either fractional power laws or logarithmic functions of the radial coordinate to investigate the spectrum of states, leptonic decay widths, and radiative decays of the psi family of resonances. The spectrum of states and the leptonic decay widths are in good agreement with the data for the entire class of potentials considered here. The radiative decays are still somewhat large for the standard model but could be brought into agreement with the data when threshold and relativistic effects are taken into account.

38451 Dispersion-theoretic study of pion factor. Pak, N.K. (Stanford Linear Accelerator Center, Calif. (USA)). *Nuovo Cim., A;* **40**: No. 1, 1-10(1 Jul 1977).

It is shown that the pion electromagnetic form factor satisfies a nonsubtracted dispersion relation if one of the pions is taken to be massless. It is possible pointed out that, by giantizing the theory on the light-cone, the mass extrapolation ambiguity due to one of the pions being massless can be overcome. This result is used to establish an upper bound on the pion charge radius.

38452 Topology of magnetic fields in particle physics, implications on the quark model. Jehle, H. (Univ. of Amsterdam). *Acta Phys. Austriaca, Suppl.;* No. 18, 63-109(1977).

From XVI proceedings on contacts between high energy physics and other fields of physics; Schladming, Austria (24 Feb 1977).

See CONF-770257—.

The flux-loop model of quarks is considered covering electomagnetic gauge invariance, flux quantization, topological conditions for the magnetic field, the extended source model, the electric field, linkage of loop forms, topology and motion of flux loop forms, coalial loops of hadrons having weak interactions, magnetic moments of hadrons, strong interactions, some remarks about string models, and the implications of he topological quark model on the ground and excited states of mesons. 80 references. (JFP)

38453 Unitary spin, colour, and unified theory. Rayski, J. (Univ., Krakow). *Acta Phys. Austriaca, Suppl.;* No. 18, 463-469(1977).

From XVI proceedings on contacts between high energy physics and other fields of physics; Schladming, Austria (24 Feb 1977).

See CONF-770257—.

Since unlike ordinaly spin the unitary spin and color have not acquired a clear, geometrical interpretation and the usual models the three colors do not yield a correct value for the asymptotic ratio, a unified theory of weak, electromagnetic, and gravitational interactions is considered. The basic idea is to treat a many-dimensional space—time with some additional compact dimensions. 6 references. (JGFP)

WEAK INTERACTIONS

REFER ALSO TO CITATION(S) 37688, 38453, 38462

38454 Measurement of the D semileptonic branching ratio in e^+e^- annihilation at the psi'' (3770). Bacino, W.; Baumgarten, A.; Birkwood, L.; Buchanan, C.; Burns, R.; Chronoviat, M.; Condon, P.; Coombes, R.; Cowell, P.; Diamant-Berger, A.; Faessler, M.; Ferguson, T.; Hall, A.; Hauptman, J.; Kirkby, J.; Kirz, J.; Liu, J.; Nodulman, L.; Ouimette, D.; Porat, D.; Rasmussen, C.; Schwartz, M.; Slater, W.; Ticho, H.K.; Wojcicki, S.; Zupancic, C. (Stanford Linear Accelerator Center and Physics Department, Stanford University, Stanford, California 49305). *Phys. Rev. Lett.;* **40**: No. 11, 671-674(13 Mar 1978).

We have observed the psi'' resonance in the cross section for $e^+e^- \rightarrow$ hadrons at E/sub c.m./ = 3770 +- 0.6 MeV, of total width Γ = 24 +- 5 MeV and partial width to electron pairs Γ/sub ee/ = 180 +- 60 eV. The cross section for hadronic events which contain anomalous electron provides both unambiguous evidence of D semileptonic decays and a branching ratio measurements of (11 +- 2) %.

38455 Nonleptonic decays of K mesons and hyperons. Valnshtein, A.I.; Zakharov, V.I.; Shifman, M.A. (Institute of Nuclear Physics, Siberian Branch of the USSR Academy of Sciences). *Sov. Phys. - JETP (Engl. Transl.);* **45**: No. 4, 670-682(Apr 1977).

Nonleptonic decays of ordinary hadrons are considered within the framework of the renormalizable vector schemes for weak interactions. An asymptotically free theory is put forward for strong interactions. All the independent operators in the effective Hamiltonian are enumerated, and expansion coefficients which take into account strong interactions at short distances are determined. The valence quark model is used to estimate the matrix elements of the operators. Transitions with $\Delta T = 3/2$ are evaluated in terms of a single parameter. The large magnitude of the amplitudes for $\Delta T = 1/2$ transitions is explained in terms of an operator producing the product of two scalars (or pseudoscalars), which is due to the presence of strong interaction in any model. This explanation rests on the assumption of small bare quark masses, which characterize violations of chiral symmetry. A number of relationships, which agree with experiment, are obtained. Estimates show that the introduction of right-handed currents is not essential for nonleptonic decays.

38456 Muon physics. Primakoff, H. (Univ. of Pennsylvania, Philadelphia). pp 1-32 of Nuclear and particle physics at intermediate energies. Warren, J.B. (ed.). New York; Plenum Press (1976).

From Proceedings of the advanced study institute in nuclear and particle physics at intermediate energies; Victoria, B.C., Canada (Jun 1975).

See CONF-7506100—.

After a brief discussion of the physical parameters of a muon in slowly varying gravitational and electromagnetic fields, the physical parameters of a muon which are characteristic of its weak interactions are considered. In particular the elementary-particle aspects of the muon decay and of its capture by a proton are treated. 12 references. (JFP)

38457 Nuclear muon-capture. Deutsch, J.P. (Univ., Louvain, Belgium). pp 33-43 of Nuclear and particle physics at intermediate energies. Warren, J.B. (ed.). New York; Plenum Press (1976).

From Proceedings of the advanced study institute in nuclear and particle physics at intermediate energies; Victoria, B.C., Canada (Jun 1975).

See CONF-7506100—.

An attempt is made to follow some of the new research lines which may open up in nuclear muon capture at the new research facilities. The discussion includes muon capture as a tool of nuclear spectroscopy, how similar are isobar analog states: a test of the elementary particle approach, how to disentangle the vector- and axial-strength in muon capture, whether nuclei are built up from nucleons only: the nuclear renormalization of the coupling constants, second-class currents, electron—muon universality: helicity of the muon neutrino, and T violation and muon capture. 71 references. (JFP)

STRONG INTERACTIONS, GENERAL

REFER ALSO TO CITATION(S) 38395

38458 (LBL—7165) **Very high energy nuclear collisions: the asymptotic hadron spectrum, anti-nuclei, hyper-nuclei, and quark phase.** Glendenning, N.K. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 2 Jan 1978. Contract W-7405-ENG-48. 51p. (CONF-780123—4). Dep. NTIS, PC A04/MF A01.

From 6. workshop on gross properties of nuclei and nuclear excitations; Hirschegg, Austria (15 Jan 1978).

The possibilities of hadron production are considered. Included are hadrons never to be discovered, relevance of the study, means of production, thermodynamics of hadronic matter, three examples of hadronic spectra, the temperature, composition of the initial fireball, expansion of the fireball, pre-freeze-out radiation, antinuclei, hypernuclei, and the quark phase. 17 references. (JFP)

38459 Hadronic fragmentation as a probe of the underlying dynamics of hadron collisions. Brodsky, S.J.; Gunion, J.F. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev., D;* **17**: No. 3, 848-857(1 Feb 1978).

We demonstrate that measurements of the power-law behavior of single and double fragmentation cross sections ($A + B \rightarrow C + X$ and $A + B \rightarrow C + D + X$) at high energies are capable of distinguishing between different models of hadronic interactions. Present evidence supports the idea that quark exchange or annihilation is the dominant strong interaction at present energies; further tests are proposed.

38460 Model of mesons with constituent gluons. Horn, D.; Mandula, J. (California Institute of Technology, Pasadena, California 91125). *Phys. Rev., D;* **17**: No. 3, 898-908(1 Feb 1978).

A model of mesons composed of a quark, an antiquark, and a gluon is proposed. The binding of the constituents is provided by a confining linear potential between the gluon and the quarks. The lowest states of the model are described, and their relative masses evaluated, for the case of heavy (charmed) quarks, i.e., ccg states.

38461 Particle physics and exotic atoms. Backenstoss, G. (Univ., Basel). *Acta Phys. Austriaca, Suppl.;* No. 18, 593-628(1977).

From XVI proceedings on contacts between high energy physics and other fields of physics; Schladming, Austria (24 Feb 1977).

See CONF-770257—.

The treatment of particle physics and exotic atoms includes the definition of exotic atoms, the formation and detection of exotic atoms and their relevance for research. Also the masses, magnetic moments and polarizability as well as strong and electromagnetic interactions with regards to vacuum polarization, parity in electromagnetic interactions, and pionic, kaonic sigma hyperonic, and antiprotonic atoms are considered. 36 references. (JFP)

38462 Some recent experiments performed at LAMPF (+- 1 year). Heffner, R. (Los Alamos Scientific Lab., NM). pp 529-548 of Nuclear and particle physics at intermediate energies. Warren, J.B. (ed.). New York; Plenum Press (1976).

From Proceedings of the advanced study institute in nuclear and particle physics at intermediate energies; Victoria, B.C., Canada (Jun 1975).

See CONF-7506100—.

Recent experiments are discussed with emphasis on the physics to be learned. Muon and hadron capture experiments, pion physics, the neutrino program, and some general experiments to be run in the next year or so are considered. 16 references. (JFP)

STRONG INTERACTIONS, BARYON NO.=0

REFER ALSO TO CITATION(S) 38473

38463 General relationship between the multiplicity and the fireball mass. Hoang, T.F.; Phua, K.K. (Department of Physics, Nanyang University, Singapore 22). *Phys. Rev., D;* **17**: No. 3, 927-930(1 Feb 1978).

A general and linear relationship is found between the fireball mass $M^\bullet$ and the multiplicity $\langle n \rangle$ of mesons from pp collisions and pp annihilations, the characteristics of $M^\bullet$ being determined by the scaling parameter used to modify the Bose-Einstein distribution. In the scaling limit, this relationship is identical with the well known power law $\langle n \rangle$ proportional E/sup 1/2/. A remark is made on its extension to asymmetric fireballs such as pion-nucleon collisions.

38464 Pion production on nuclei. Reitan, A. (Univ. of Trondheim, Norway). pp 393-424 of Nuclear and particle physics at

intermediate energies. Warren, J.B. (ed.). New York; Plenum Press (1976).

From Proceedings of the advanced study institute in nuclear and particle physics at intermediate energies; Victoria, B.C., Canada (Jun 1975).

See CONF-7506100—.

The discussion of nuclear pion production covers the experimental situation, qualitative features, the one- and two-nucleon models, and reaction theory. 41 references. (JFP)

STRONG INTERACTIONS, BARYON NO.=1

38465 Implication of the Chou-Yang mdoel in πp elastic scattering. Chan, S.C.; Lo, S.Y.; Low, H.B.; Phua, K.K. (Department of Physics, Nanyang University, Singapore 22). *Phys. Rev., D;* **17**: No. 3, 802-805(1 Feb 1978).

With some knowledge of the pion form factor, we study πp elastic scattering with the Chou-Yang model. We find it agrees very well with recent Fermilab measurements and we predict the existence of a dip at -t = 4-5 GeV^2. The sensitivity of the dip structure due to the variation of the shape of the pion form factor is studied.

38466 Interactions of pions with nuclei. Scheck, F. (SIN, Zurich). pp 299-342 of Nuclear and particle physics at intermediate energies. Warren, J.B. (ed.). New York; Plenum Press (1976).

From Proceedings of the advanced study institute in nuclear and particle physics at intermediate energies; Victoria, B.C., Canada (Jun 1975).

See CONF-7506100—.

A pedagogical and mostly introductory treatment of the interactions of pions with nuclei is given covering the basic features of pion—nucleon and pion—nucleus interactions, the optical potential in the static approximation, fixed-scattering approximation, off-shell effects and Beg theorem, the N* resonance in pion—nucleus interactions, and nuclear physics from pionic atoms. 28 references. (JFP)

STRONG INTERACTIONS, BARYON NO. GREATER THAN 1

REFER ALSO TO CITATION(S) 38466

38467 (COO—3069-560) **Relativistic heavy ions.** Feshbach, H. (Massachusetts Inst. of Tech., Cambridge (USA)). 1977. Contract EY-76-C-02-3069. 37p. (CONF-770873—4). Dep. NTIS, PC A03/MF A01.

From 7. international conference on high energy physics and nuclear structure; Zurich, Switzerland (30 Aug 1977).

A brief review is presented of our present understanding of reactions induced by relativistic heavy ions.

38468 Hadron structure and high-energy hadron-deuteron collisions. Baker, M.; Lubatti, H.J.; Rogers, E.O.; Weis, J.H. (Physics Department, University of Washington, Seattle, Washington 98195). *Phys. Rev., D;* **17**: No. 3, 826-838(1 Feb 1978).

Recently at Fermilab, data on high-energy hadron-deuteron interactions for a number of projectiles and energies have become available. Here we collect these data and show how they can be used to test the conventional space-time picture of hadron interactions which is based on the assumed absence of singular short-range forces. In particular, these experiments may well provide the first clear evidence for double-ladder processes. Furthermore, the cross section and multiplicity data for double-scattering processes (interaction of both proton and neutron with the incident hadron) can be used to test the Abramovskii-Gribov-Kancheli cutting rules. We find that theory and experiment are in good agreement, but a more definitive test of the theory will require further theoretical work and more precise data.

38469 Transverse-momentum and angular distributions of hadroproduced muon pairs. Berger, E.L.; Donohue, J.T.; Wolfram, S. (High Energy Physics Division, Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., D;* **17**: No. 3, 858-861(1 Feb 1978).

We study the angular distribution of muons in the dimuon rest frame from pp $\rightarrow \mu\mu^*$;mX at high energy and large dimuon mass. Including smearing due to quark transverse momenta, we show that the Drell-Yan model predicts a polar angular distribution in the t-channel helicity frame of $1 + \alpha \cos^2\theta$ with $\alpha > $ or $\simeq 0.8$. Experimental deviations from this prediction would case serious doubt on the Drell-Yan picture.

38470 High-energy hadron-nucleus collisions. Bialkowski, G.; Chiu, C.B.; Tow, D.M. (Institute for Theoretical Physics, University of Warsaw, Warsaw, Poland). *Phys. Rev., D;* **17**: No. 3, 862-869(1 Feb 1978).

A new space-time model for hadron-nucleus collisions is proposed, in which produced particles at the instant of creation not only are immature, but their maturity rate is enhanced in the presence of other hadronic matter, as in a nucleus. The model's only free parameter, describing the maturity enhancement, is fixed by normalizing to the 200-GeV p-A multiplicity data at a fixed A. The parameter-free model then predicts correctly the p-A differential multiplicity as function of the pseudorapidity eta and A, the multiplicity energy dependence, the π-A differential multiplicity, and the A-dependences of σ/sup pA//sub inel/ and σ/sup piA//sub inel/. We also show quantitatively that the so-called cut-type model and fan-plus-cut-type model do not agree with the data.

38471 Interaction of J/psi particles with nucleons and nuclei in the soliton model. Kondratyuk, L.A.; Shapiro, I.S. (Institute of Theoretical and Experimental Physics). *Sov. Phys. - JETP (Engl. Transl.);* **45**: No. 4, 659-666(Apr 1977).

It is shown that, within the framework of the soliton model of J/psi particles, the (J/psi)N interaction can be regarded as the scattering of the nucleon by an external classical field. The phase shifts are then real and the total and elastic cross sections for this interaction are equal (if diffractional dissociation processes are neglected). The model is in qualitative agreement with existing experimental data on the photoproduction of J/psi particles on nucleons and nuclei. The coherent and noncoherent cross sections for the photoproduction of J/psi particles on nuclei are calculated, and it is shown that measurement of these cross sections as functions of the number of nucleons in the nucleus, the momentum transfer to the nucleus, and the photon energy can be used to determine the real and imaginary parts of the amplitude for (J/psi)N scattering and the slope of the differential cross section.

38472 Particle physics and exotic atoms. Scheck, F. (Johannes Gutenberg-Universitat, Mainz). *Acta Phys. Austriaca, Suppl.;* No. 18, 629-675(1977).

From XVI proceedings on contacts between high energy physics and other fields of physics; Schladming, Austria (24 Feb 1977).

See CONF-770257—.

The discussed relation of particle physics with exotic atoms includes tests of quantum electrodynamics using muonic atoms, weak interaction phenomena as detected by means of muonic atoms, and properties of hadronic atoms. 57 references. (JFP)

38473 Interactions of hadrons with nuclei at high energy. Alberi, G. (Istituto di Fisica Teorica, Trieste, Italy). *Acta Phys. Austriaca, Suppl.;* No. 18, 727-788(1977).

From XVI proceedings on contacts between high energy physics and other fields of physics; Schladming, Austria (24 Feb 1977).

See CONF-770257—.

It is noted that at high energies the nucleus can in most cases be described just as a matter distribution for the study of hadron reactions. The idea of coherent and multiple production experiments is to learn about the diffractive states of the hadrons and their interactions with the nuclear environment or about the dynamics of multiparticle production; but for very precise proton elastic scattering experiments the difference between proton and neutron distribution could be relevant, to explain discrepancies between theory and experiments. It is found that the Glauber—eikonal theory greatly simplifies the complication of the many body problem and makes it possible to extract microscopic nuclear structure information from the data. As applications elastic and inelastic scattering of protons, coherent and semicoherent production and regeneration of K^0. Also the multiparticle production data and a few phenomenological models, which explain experimental data making a hypothesis on the time evolution of the multiple production process, are considered. 42 referenes. (JFP)

PARTICLE INVARIANCE PRINCIPLES AND SYMMETRIES

38474 Invariance principles. Kabir, P.K. (Univ. of Virginia, Charlottesville). pp 59-85 of Nuclear and particle physics at intermediate energies. Warren, J.B. (ed.). New York; Plenum Press (1976).

From Proceedings of the advanced study institute in nuclear and particle physics at intermediate energies; Victoria, B.C., Canada (Jun 1975).

See CONF-7506100—.

The discussion of invariance principles and their role in physical theory includes internal symmetries, nuclear and atomic parity nonconservation, and time-reversal invariance. 2 references. (JFP)

GENERAL

38475 Algebra of color. Domokos, G.; Koevesi-Domokos, S. (Department of Physics, The Johns Hopkins University, Baltimore,

Maryland 21218). *J. Math. Phys. (N.Y.);* 19: No. 6, 1477-1481(Jun 1978).

We construct an algebra of (local) dynamical variables which satisfies the triality rule for quarks and an exact superselection rule between leptons and quarks. This algebra is isomorphic to a noncommutative Jordan algebra; hence, it is power associative. Inner derivations are constructed explicitly: Their algebra is isomorphic to Lie SU(3); the latter can be identified with the group of color symmetry.

APPLICATIONS TO ELECTROMAGNETIC AND WEAK INTERACTIONS

38476 Higher-order corrections to parity violation in atoms in SU(2) x U(1) models. Senjanovic, G. (The City College of The City University of New York, New York, N. Y. 10031). *Phys. Rev., D;* 17: No. 3, 892-897(1 Feb 1978).

We calculate the higher-order corrections to the parity-violating amplitude for electron-up (-down) quark amplitudes in SU(2) x U(1) models. We also discuss the implications of our results for atomic transitions and make comparison with a class of models based on the gauge group SU(2)/sub L/ x SU(2)/sub R/ x U(1) that has an absence of parity violation in atoms in the lowest order.

FIELD THEORY

REFER ALSO TO CITATION(S) 38353, 38448, 38452, 38472

38477 Quantized electric flux tubes in quantum chromodynamics. Bars, I. (Department of Physics, Yale University, New Haven, Connecticut 06520). *Phys. Rev. Lett.;* 40: No. 11, 688-691(13 Mar 1978).

It is shown that in the strong-coupling limits the spectrum of quantum chromodynamics consists of closed and open strings with quarks at the ends. A Hamiltonian formulation in the axial gauge A/ sup a/$_3$ = 0 is used. The theory is reformulated in terms of new canonical variables. Algebraic methods are employed to arrive at these results.

38478 Explicit dimensional renormalization of quantum field theory in curved space-time. Duncan, A. (Columbia University, New York, New York 10027). *Phys. Rev., D;* 17: No. 4, 964-971(15 Feb 1978).

The dimensional renormalization of scalar and spinor field theories quantized in a conformally flat (k = 0) Robertson-Walker space-time is discussed. The theories considered are conformally invariant save explicit mass terms. All calculations are performed on the level of the canonical, Heisenberg-picture field theory, and explicit formulas derived for renormalized Heisenberg-state expectation values, such as particle production. Some solvable models are presented as illustrations of the formalism.

38479 Embedding classical fields in quantum field theories. Blaha, S. (Physics Department, Syracuse University, Syracuse, New York 13210). *Phys. Rev., D;* 17: No. 4, 994-1008(15 Feb 1978).

We describe a procedure for quantizing a classical field theory which is the field-theoretica analog of Sudarshan's method for embedding a classical-mechanical system in a quantum-mechanical system. The essence of the difference between our quantization procedure and Fock-space quantization lies in the choice of vacuum states. The key to our choice of vacuum is the procedure we outline for constructing Lagrangians which have gradient terms linear in the field varialbes from classical Lagrangians which have gradient terms which are quadratic in field variables. We apply this procedure to model electrodynamic field theories, Yang-Mills theories, and a vierbein model of gravity. In the case of electrodynamics models we find a formalism with a close similarity to the coherent-soft-photon-state formalism of QED. In addition, photons propagate to t = + ∞ via retarded propagators. We also show how to construct a quantum field for action-at-a-distance electrodynamics. In the Yang-Mills case we show that a previously suggested model for quark confinement necessarily has gluons with principle-value propagation which allows the model to be unitary despite the presence of higher-order-derivative field equations. In the vierbein-gravity model we show that our quantization procedure allows us to treat the classical and quantum parts of the metric field in a unified manner. We find a new perturbation scheme for quantum gravity as a result.

38480 Polynomial conservation laws in (1 + 1) -dimensional classical and quantum field theory. Thacker, H.B. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). *Phys. Rev., D;* 17: No. 4, 1031-1040(15 Feb 1978).

The quantum-mechanical implications of the inverse-scattering-transform method and its relationship to the structure of Bethe's ansatz are discussed in the context of the nonlinear Schroedinger equation (many-body problem) associated with the classical (quantum) field theory L = (i/2) phi*partial$_0$phi - vertical-barpartial$_1$phivertical-bar^2 - cvertical-barphivertical-bar^4. We review the transformation of the classical problem to action and angle variables and the derivation of an infinite number of polynomial conservation laws. The values of the conserved constants are given by the moments of the classical action variable. It is suggested that there exists a corresponding set of conserved polynomial operators in the quantum field theory and that they reflect the conservation of velocity content which characterizes the solution of the many-body scattering problem (Bethe's ansatz). This implies that the quantized action variable is just the occupation-number density operator in the asymptotic momentum- (velocity-) parameter space of Bethe's ansatz, and that Bethe's wave functions are eigenstates of all conserved operators with eigenvalues given by the moments of the N-particle distribution in asymptotic momentum space. These statements are verified for the first four operators, including one which has not previously been studied.

38481 Note on the Atiyah-Singer index theorem. Bernard, C.W.; Guth, A.H.; Weinberg, E.J. (Department of Physics, Columbia University, New York, New York 10027). *Phys. Rev., D;* 17: No. 4, 1053-1055(15 Feb 1978).

The Atiyah-Singer index theorem has recently been used to determine the number of parameters entering the general self-dual Euclidena Yang-Mills configuration with a given topological charge. We give a simple derivation of the form which the index theorem takes in this application.

38482 Derivation of dual models from field theory. II. Thorn, C.B. (Center for Theoretical Physics, Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology. Cambridge, Massachusetts 02139). *Phys. Rev., D;* 17: No. 4, 1073-1085(15 Feb 1978).

We rewrite λphi^4 theory as a dual string expansion by performing a combined topological strong-coupling expansion on an x$^+$, P$^+$ lattice. The resulting expansion is the standard dual loop expansion plus the point-energy-momentum density graphs of Green. The expansion goes through only for the "wrong" sign of λ, i.e., when the theory is asymptotically free and infrared unstable. The coupling strength λ is fixed by an eigenvalue condition, and the rest tension of the string, T$_0$, replaces it as a free parameter. The continuum limit only exists for the critical dimension D = 26. We suggest that this approach might be a suitable starting point for spectrum calculations in quantum chromodynamics.

38483 Fermion Green's functions in the presence of pseudoparticles. Mottola, E. (Columbia University, New York, N.Y. 10027). *Phys. Rev., D;* 17: No. 4, 1103-1108(15 Feb 1978).

A systematic graphical approach to the calculation of fermion amplitudes in the presence of Yang-Mills pseudoparticles is presented. In the multi-pseudoparticle "dilute gas" limit, the method is equivalent to that of the effective Lagrangian approach; the corrections to this limit are also indicated.

38484 Classical concepts in quantum contexts. Klauder, J.R. (Bell Labs., Murray Hill, NJ). *Acta Phys. Austriaca, Suppl.;* No. 18, 1-62(1977).

From XVI proceedings on contacts between high energy physics and other fields of physics; Schladming, Austria (24 Feb 1977).

See CONF-770257—.

Several recent proposals in quantum field theory that make use of classical soliton (in the wide sense) solutions and semi-classical quantization techniques are reviewed and illustrated with various examples.

38485 Classical limit of quantum electrodynamics. Bialynicki-Birula, I. (Inst. of Theoretical Physics, Warsaw). *Acta Phys. Austriaca, Suppl.;* No. 18, 111-151(1977).

From XVI proceedings on contacts between high energy physics and other fields of physics; Schladming, Austria (24 Feb 1977).

See CONF-770257—.

The review of classical limits in quantum electrodynamics includes the hydrodynamic formulation and the Weyl-Wigner-Moyal transforms for the classical limit of nonrelativistic quantum mechanics, the classical limit of relativistic quantum mechanics, and the classical limit of the quantum theory of the electromagnetic field in terms of photon number states and in terms of coherent states, and the classical and low frequency limits. 38 references. (JFP)

38486 Physics of strong fields in quantum electrodynamics and general relativity. Mueller, B.; Greiner, W. (Inst. for Theoretical Physics, Frankfurt am Main). *Acta Phys. Austriaca, Suppl.;* No. 18, 153-384(1977).

From XVI proceedings on contacts between high energy physics and other fields of physics; Schladming, Austria (24 Feb 1977).

See CONF-770257—.

A review is given of the charged vacuum in strong electrostatic fields starting from the physics of the atomic electrons when the charge of the nucleus is considerably increased. A model is introduced treating the decay of the neutral vacuum as an autoionization process of positrons. This idea is quantitatively justified giving the exact single particle solutions of the Dirac equation with external Coulomb potential for all Z'. Quantization is carried out while maintaining the concept of overcritical states. The behavior of vacuum polarization in strong fields, and the consequences of certain phenomenologically introduced nonlinear extensions of the theory are scrutinized. It is shown that the diving of electronic levels cannot be prevented by any known causes. Lastly a short statistical description of the charged vacuum which is interesting in connection with hypothetical very highly charged nuclei is given. 171 references. (JFP)

38487 Solitons and instantons in quantum field theory. Gervais, J.L. (Laboratoire de Physique Theorique de l'Ecole Normale Superieure, Paris). *Acta Phys. Austriaca, Suppl.;* No. 18, 385-428(1977).

From XVI proceedings on contacts between high energy physics and other fields of physics; Schladming, Austria (24 Feb 1977).

See CONF-770257—.

The parameters involved in classical solutions in quantum field theory have the effect that the change in field is not well defined. Therefore these parameters are considered as dynamical variables which should be determined from the field itself. Those dynamical variables are interpreted physically as soliton position and momenta or Euclidean space—time regions where tunneling occurs. This aspect of the semiclassical method is mainly considered, and a review given of some works performed over the last two years. 37 references. (JFP)

38488 Boson—Fermion correspondence in quantum theory and quantization of spinor fields. Garbaczewski, P. (Univ., Wroclaw). *Acta Phys. Austriaca, Suppl.;* No. 18, 445-461(1977).

From XVI proceedings on contacts between high energy physics and other fields of physics; Schladming, Austria (24 Feb 1977).

See CONF-770257—.

The treatment of boson—fermion correspondence in quantum theory and the quantization of spinor fields covers the phi_3^4 justification and what can be drawn from the boson system, fermion—boson correspondence in the Fock construction, a selected application to the isotropic Heisenberg lattice, and the correspondence principle in quantum field theory for quantization of spinor fields with no use of anticommuting c numbers. 22 references. (JFP)

38489 Methods of nonrelativistic quantum field theory. Kehr, K.W. (Kernforschungsanlage, Juelich, Ger.). *Acta Phys. Austriaca, Suppl.;* No. 18, 471-541(1977).

From XVI proceedings on contacts between high energy physics and other fields of physics; Schladming, Austria (24 Feb 1977).

See CONF-770257—.

Lectures are given on many-body systems consisting of fermions or bosons which interact with two-particle interactions. Green functions at zero temperature, Feynman diagrams, perturbation methods for the self-energy, finite-temperature Green function, systems with broken symmetry, and superconductivity are considered. 22 references. (JFP)

38490 Probabilistic ideas in field theory and statistical mechanics. Lasinio, G.J. (Univ., Rome). *Acta Phys. Austriaca, Suppl.;* No. 18, 589-592(1977).

From XVI proceedings on contacts between high energy physics and other fields of physics; Schladming, Austria (24 Feb 1977).

See CONF-770257—.

An annotated bibliography is presented on probabilistic ideas in field theory and statistical mechanics. These lectures stress and illustrate the increasing role of probability theory in unifying a number of problems in quantum mechanics, quantum field theory and classical statistical mechanics. (JFP)

38491 Covariant treatment of particle creation in external fields. Rumpf, H. (Univ., Vienna). *Acta Phys. Austriaca, Suppl.;* No. 18, 873-883(1977).

From XVI proceedings on contacts between high energy physics and other fields of physics; Schladming, Austria (24 Feb 1977).

See CONF-770257—.

A particle definition is proposed making use of none of the previous features. The assumptions made arise naturally from the mathematical structure of scalar field theory and seem to be so general that one might accept them as the indispensable ingredients for the notion of particle to make sense at all. Although generalizations are possible, only a charged scalar field coupled to an external electromagnetic potential and metric are considered. Some results obtained with this definition in special electromagnetic and gravitational fields are presented. 5 references. (JFP)

SCATTERING THEORY

38492 No-go theorem for polarization structure. Goldstein, G.R.; Moravcsik, M.J. (Department of Physics, Tufts University, Medford, Massachusetts 02155). *J. Math. Phys. (N.Y.);* **19**: No. 6, 1371-1375(Jun 1978).

It would be extremely advantageous, from the point of view of the planning of experiments and of the testing of theoretical models by such experiments, if a representation of the reaction matrix could be found such that the differential cross section is given by the absolute value squared of a single amplitude, and the simplest type of polarization experiments are expressed in terms of functions involving only two amplitudes each. It is shown that, within the framework of a set of plausible and very weak constraints, such a representation does not exist.

38493 Vanishing closure correction in the second-order optical potential. Miller, G.A.; Austern, N.; Silver, M. (Department of Physics, University of Washington, Seattle, Washington 98195). *Phys. Rev., C;* **17**: No. 2, 835-836(Feb 1978).

The first-order correction to the closure approximation in the multiple-scattering calculation of the second-order optical potential is shown to vanish under rather general conditions.

38494 Scattering of quantized solitons in the nonlinear Schroedinger theory. Schlindwein, M. (Univ., Freiburg i. B.). *Acta Phys. Austriaca, Suppl.;* No. 18, 429-444(1977).

From XVI proceedings on contacts between high energy physics and other fields of physics; Schladming, Austria (24 Feb 1977).

See CONF-770257—.

The application of the general scattering formalism to the bound state scattering in the nonlinear Schroedinger theory is presented. This model is of special interest as it can be treated either as a second quantized field theory or as a quantum mechanical problem of N particles interacting via potentials of the gamma function type. Therefore, by comparing the exact quantum mechanical results with the semiclassical treatment one may control the validity of the approximations. The scattering formalism is first reviewd, then a description is given of how to calculate the classical phase shift for soliton—soliton scattering. The treatment of the quantum corrections is given up to the one-loop level, and finally the exact results are compared with the semiclassical answers. 16 references. (JFP)

PHYSICS RESEARCH (CONT.)

NUCLEAR PHYSICS

REFER ALSO TO CITATION(S) 38421

38495 (ORO—2972-3) **Experimental measurements at LAMPF. Progress report, January 1, 1977—December 31, 1977.** (Texas Univ., Austin (USA)). 1977. Contract EY-76-C-05-2972. 53p. Dep. NTIS, PC A04/MF A01.

Progress is summarized for research in medium energy nuclear physics at LAMPF, conducted by the University of Texas at Austin, January 1, 1977 to December 31, 1977. (SDF)

38496 (ORO—2972-16) **Progress in, theoretical nuclear physics, research: January 1, 1977—December 31, 1977.** (Texas Univ., Austin (USA). Dept. of Physics). Jan 1978. Contract EY-76-C-05-2972. 72p. Dep. NTIS, PC A04/MF A01.

This is a progress report, describing the accomplishments in basic research in nuclear physics carried out by the theoretical nuclear physics group of the Department of Physics of The University of Texas at Austin, during the period of January 1, 1977 to December 31, 1977.

38497 (ORO—4936-3) **Progress report on nuclear spectroscopic studies, June 1, 1977—May 31, 1978.** Bingham, C.R.; Riedinger, L.L.; Guidry, M.W. (Tennessee Univ., Knoxville (USA). Dept. of Physics and Astronomy). 1 Mar 1978. 84p. Dep. NTIS, PC A05/MF A01.

Portions of document are illegible.

Research progress is summarized for activities of the University of Tennessee department of physics and astronomy in the

following areas: (1) in-beam spectroscopy of high-spin state, (2) Coulomb-nuclear interference and inelastic heavy ion scattering (3) Coulomb excitation, nuclear theory, (4) nuclear structure studies with alpha-induced direct reactions, and (5) developmental activities. (SDF)

38498 Recent References. Ewbank, W.B.; Haese, R.L.; Hurley, F.W.; McGinnis, M.R. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Nucl. Data Sheets;* **23**: No. 3, 349-353(Mar 1978).

References, key words, key numbers, and reaction indexing are given for all literature received by the Nuclear Data Project or assigned key numbers between September 1977 and December 1977.(AIP)

38499 Problems of a nuclear data centre in an international network. Attree, P.M. (IAEA Nuclear Data Section, Vienna). pp 268-275 of Generalized data management systems and scientific information. Paris; OECD Nuclear Energy Agency (1978).

From OECD/NEA working group on nuclear information; Berkeley, CA, USA (5 Oct 1977).

See CONF-771062—.

The environment within which the Nuclear Data Section (NDS) of the International Atomic Energy Agency (IAEA) operates, the systems which currently exist, and possible NDS use of the ADABAS system when it becomes available for general use within the IAEA at the end of 1977 are discussed. 3 figures. (RWR)

NUCLEAR PROPERTIES AND REACTIONS, A=1-5, THEORETICAL

NUCLEAR REACTIONS AND SCATTERING

38500 Radiative pion capture and muon capture in three-nucleon systems. Phillips, A.C. (Univ. of Manchester, Eng.). pp 359-368 of Nuclear and particle physics at intermediate energies. Warren, J.B. (ed.). New York; Plenum Press (1976).

From Proceedings of the advanced study institute in nuclear and particle physics at intermediate energies; Victoria, B.C., Canada (Jun 1975).

See CONF-7506100—.

Some elementary particle and impulse approximation method calculations for radiative pion capture agd muon capture in three-nucleon systems are described for the reactions $\mu^- + {}^3He \rightarrow {}^3H + \nu_1$ nd + ν_1 and nnp + ν; $\mu^- + {}^3H \rightarrow$ nnn + ν; $\pi^- + {}^3He \rightarrow {}^3H + \gamma$, nd + γ, and nnp + γ; and $\pi^- + {}^3H \rightarrow$ nnn + γ. The transitions from ^{3}He to ^{3}H and from ^{3}H and ^{3}He to three-nucleon continuum states are considered. 8 references. (JFP)

NUCLEAR PROPERTIES AND REACTIONS, A=6-19 THEORETICAL

MASS, ABUNDANCE, AND BINDING ENERGY

38501 Effect of pion distortion on the asymmetry in (p,π^+) reactions on light nuclei. Young, S.K.; Gibbs, W.R. (Theoretical Division, Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Rev., C;* **17**: No. 2, 837-841(Feb 1978).

Recent (p,π^+) experiments on ^{12}C at 200 MeV proton bombarding energy indicate that the production asymmetry ϵ cannot be explained (within the distorted-wave Born-approximation framework) by proton distortion alone. We examine in a simple model the effect of pion rescattering from the nucleus. The dependence of ϵ on the pion wave function, as well as its sensitivity to nuclear structure and the pion production operator are studied. The implication of the large negative asymmetry observed experimentally is briefly discussed.

NUCLEAR REACTIONS AND SCATTERING

38502 Resonating-group study of the n + ^{6}Li system. Stubeda, D.J.; LeMere, M.; Tang, Y.C. (School of Physics and Astronomy, University of Minnesota, Minneapolis, Minnesota 55455). *Phys. Rev., C;* **17**: No. 2, 447-454(Feb 1978).

The resonating-group method, together with a complex-generator-coordinate technique, is used to investigate the n + ^{6}Li scattering problem. The result shows that, by including a phenomenological imaginary potential in the formulation to take approximate account of reaction effects, a good agreement with experiment can be obtained for both the differential scattering and the total reaction cross sections. The effect of the Pauli principle on the nature of the effective internuclear potential is also examined. Here it is found that the blocking effect, arising from the presence of two nucleons in the nonclosed 1p shell of ^{6}Li, has a profound influence on the odd-even orbital-angular-momentum dependence of this potential.

38503 Quasifree scattering of kaons. Alexander, Y.; Moffa, P.J. (Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). *Phys. Rev., C;* **17**: No. 2, 676-680(Feb 1978).

The inclusive scattering of K^+ mesons on ^{12}C is calculated in the plane wave impulse approximation. The momentum distribution employed for ^{12}C and different reaction mechanism approaches are checked by a comparison with data of a calculation of the inclusive scattering of electrons on ^{12}C.

NUCLEAR PROPERTIES AND REACTIONS, A=6-19, EXPERIMENTAL

ENERGY LEVELS AND TRANSITIONS

38504 Search for neutral-weak-current effects in the nucleus ^{18}F. Barnes, C.A.; Lowry, M.M.; Davidson, J.M.; Marrs, R.E.; Morinigo, F.B.; Chang, B.; Adelberger, E.G.; Swanson, H.E. (California Institute of Technology, Pasadena, California 91125). *Phys. Rev. Lett.;* **40**: No. 13, 840-843(27 Mar 1978).

The circular polarization of the γ rays from the 1.08 → 0.0 MeV transition of ^{18}F has been measured to be (-0.7 +- 2.0) x 10^{-3}, a value significantly smaller than predicted by recent calculations which include the effects of neutral weak currents.

NUCLEAR REACTIONS AND SCATTERING

38505 Partial widths of molecular resonances in the system ^{12}C + ^{12}C. Cormier, T.M.; Jachcinski, C.M.; Berkowitz, G.M.; Braun-Munzinger, P.; Cormier, P.M.; Gai, M.; Harris, J.W.; Barrette, J.; Wegner, H.E. (Department of Physics, State University of New York at Stony Brook, Stony Brook, New York 11794). *Phys. Rev. Lett.;* **40**: No. 14, 924-927(3 Apr 1978).

Total-cross-section excitation functions for ^{12}C + ^{12}C single and mutual inelastic scattering, and fusion, have been analyzed to yield partial widths of the J/sup π/= (10^+), (12^+), and (14^+) gross structure resonances. The results are shown to be consistent with the double-resonances picture in which the strongly collective 2_1^+ inelastic excitations act as doorway states.

38506 Isospin conservation in the reactions ^{16}O(p,t)^{14}O(g.s.) and ^{16}O(p,^{3}He)^{14}N(2.31 MeV). Goodman, C.D.; Hanson, D.L.; Hensley, D.C.; Stokstad, R.G. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., C;* **17**: No. 2, 493-500(Feb 1978).

Differential cross section measurements are given for the isospin related reaction channels ^{16}O(p,t)^{14}O(g.s.) and ^{16}O(p,^{3}He)^{14}N(2.31 MeV) for several proton energies near 29 MeV. The isospin mixture of the exit channel changes significantly with small changes in bombarding energy. Distorted-wave Born approximation calculations reproduce the changes reasonably well. Calculations show, however, that compound nuclear contributions might be large.

NUCLEAR PROPERTIES AND REACTIONS, A=20-38, THEORETICAL

RADIOACTIVE DECAY

38507 Beta spectrum of ^{20}F. Calaprice, F.P.; Alburger, D.E. (Joseph Henry Laboratories, Princeton University, Princeton, New Jersey 08540). *Phys. Rev., C;* **17**: No. 2, 730-738(Feb 1978).

The shape of the β-ray spectrum of ^{20}F has been investigated as a test of the weak magnetism prediction of the conserved vector current theory. Using the radiative width of the analog M1 decay in ^{20}Ne to determine the magnetic form factor we calculate, from conserved vector current theory, a deviation of the β spectrum from the allowed shape of +1.23 +- 0.03% MeV^{-1}. Higher order terms reduce the slope to 0.94% MeV^{-1}. The spectrum was measured with an iron-free intermediate-image magnetic spectrometer and the deviation was found to +0.04 +- 0.5% MeV^{-1} or somewhat smaller than the conserved vector current prediction.

NUCLEAR PROPERTIES AND REACTIONS, A=20-38, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

38508 ^{238}U + n resolved resonance energies. Olsen, D.K.; de Saussure, G.; Perez, R.B.; Difilippo, F.C.; Ingle, R.W. (Oak Ridge National Lab., TN). *Nucl. Sci. Eng.;* **66**: No. 1, 141-144(Apr 1978).

Neutron transmission measurements from 100 eV to 170 keV at 150 m through four ^{238}U samples are reported. The energy calibration is described, and the resultant ^{233}U resolved resonance energies are found to be intermediate between those from other workers. In addition, some energies for sharp resonances in ^{23}Na, ^{27}Al, ^{32}S, and ^{206}Pb are given.

NUCLEAR PROPERTIES AND REACTIONS, A=39-58, THEORETICAL

NUCLEAR REACTIONS AND SCATTERING

38509 Evidence for a complex L x S interaction in the deuteron-nucleus optical potential. Goddard, R.P.; Haeberli, W. (University of Wisconsin, Madison, Wisconsin 53706). *Phys. Rev. Lett.;* **40**: No. 11, 701-703(13 Mar 1978).

The addition of an imaginary L x S interaction to the deuteron-nucleus optical potential signficantly improves the fit to cross-section and analyzing-power measurements for elastic scattering of 10-15-MeV deuterons from medium-weight nuclei. The largest improvement results from a shift of the analyzing powers toward smaller angles, relative to the cross section. The imaginary L x S potential has the same sign and about one-half the strength of the real L x S potential.

38510 Surface transparent potentials and coupled-channel Born-approximation study of diffractive behavior in heavy-ion induced reactions. Baltz, A.J.; Kahana, S. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., C;* **17**: No. 2, 555-575(Feb 1978).

Coupled channel explanations, which have been offered for the diffractive behavior observed in the differential ground state-ground state cross sections of (^{16}O,^{18}O) reactions on Ni isotopes, are in apparent disagreement with data for transfer to the $^{18}O(2^+)$ state. A study of available quasielastic reaction data, elastic, inelastic, and transfer suggests the surface-transparent potentials both can better describe the optical phenomena observed in the angular shapes and can minimize effects due to coupled channels. As a by-product a description, which does not require a large $^{18}O(2^+_1)$ quadrupole moment, is obtained for the troublesome angular distribution in ^{18}O + ^{58}Ni inelastic scattering.

38511 Calculations of single-particle polarization using a realistic two-center shell model. Pruess, K. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.); Lichtner, P. (Maryland Univ., College Park (USA)). *Nucl. Phys., A;* **291**: No. 2, 475-509(14 Nov 1977).

In 'slow' nucleus-nucleus collisions the single-particle states will adjust continuously to an instantaneous two-center potential. Rearrangement reactions will occur between polarized rather than between asymptotic states. A previous investigation of polarized single-particle states is extended to a realistic two-center model including Coulomb forces. The dependence of polarization upon physical parameters is discussed. Polarization of states which participate in transfer reactions initiated by $^{40}Ca+^{16}O$, and in the reaction $^{208}Pb(^{12}C, ^{11}B)^{209}Bi$, is analyzed in detail. In the former system a strong resonance polarization is found for some neutron states. A two-state approximation is employed to estimate the evolution of polarization in time. The authors predict that, in many cases, typical direct interaction times are sufficient for strong polarization to develop. Observable consequences of this are discussed in a qualitative way. Suggestions are also made for further theoretical and experimental work.

NUCLEAR PROPERTIES AND REACTIONS, A=39-58, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

38512 Charged-particle-producing reactions of 15-MeV neutrons on ^{51}V and ^{93}Nb. Grimes, S.M.; Haight, R.C.; Anderson, J.D. (Lawrence Livermore Laboratory, Livermore, California 94550). *Phys. Rev., C;* **17**: No. 2, 508-515(Feb 1978).

Cross sections for the (n,xp), (n,d), and (n,xα) reactions for 15-MeV neutrons on ^{51}V and ^{93}Nb have been measured with a magnetic quadrupole spectrometer. The importance of the (n,n'p) reaction as a source of protons is examined by comparing these results with those recently obtained for ^{46}Ti. Good fits to the (n,xp) and (n,xα) energy spectra require contributions from both equilibrium and nonequilibrium reactions, while only the latter appear in the (n,d) spectra. Calculated values for the (n,n'p) and (n,n'α) cross sections agree well with the experimental values. The cross sections are ^{51}V(n,xp) 91 +- 14 mb, ^{51}V(n,xd) 7 +- 3 mb, ^{51}V(n,xα) 17 +- 3 mb, ^{93}Nb(n,xp) 51 +- 8 mb, ^{93}Nb(n,xd) 8 +- 3 mb, and ^{93}Nb(n,xα) 14 +- 3 mb.

38513 Neutron resonances in ^{45}Sc and their relation to thermal scattering parameters. Chrien, R.E.; Liou, H.I. (Brookhaven National Lab., Upton, N.Y. (USA)); Block, R.C. (Rensselaer Polytechnic Inst., Troy, N.Y. (USA). RPI Linac Lab.); Kobayashi, K. (Kyoto Univ., Kumatori, Osaka (Japan). Research Reactor Inst.). *Phys. Lett., B;* **71**: No. 2, 311-313(21 Nov 1977).

The total neutron cross section of ^{45}Sc from 400 eV to 22 keV has been measured. The results are shown to be incompatible with the postulate that a J=4 bound state dominates thermal scattering.

38514 (UCRL-Trans—11320) **Determination of "14 MeV" cross sections for (n,p)-, (n,alpha)-, (n,2n)- and (n, np + pn + d) reactions in the elements Sc, Ni, Ge, Pd, Cd, Sm, Dy, Gd, and Yb with consideration of the "effective" neutron energy spectra.** Weigel, H.; Michel, R.; Herr, W. Translated from *Radiochim. Acta;* **22**: No. 1/2, 11-19(1975). 23p. Dep. NTIS, PC A02/MF A01.

A total of 24 cross sections was determined for (n,p)-, (n,α)-, (n,2n)- and (n,np + pn + d)-reactions of fast (so called "14 MeV") neutrons on the elements Sc, Ni, Ge, Pd, Cd, Sm, Dy, Gd, and Yb. $^{58}Ni(n,p)^{58}Co$ served as monitor reaction. It is a special feature that calculated neutron energy spectra for the "14 MeV" n-tube (Type Philips 18602) were considered, thus enabling the supply of each individual sigma-value with the respective n-energy distribution. On the basis of an extensive literature search (up to the beginning of 1973) the sigma-data were compared with experimental results of other authors and with those deduced from the statistical model. For some nuclides (e.g. ^{58}Ni, ^{154}Gd, ^{168}Yb, ^{176}Yb) it was possible to show the limits of applicability of the latter model. Summarizing, 12 cross sections and 3 isomeric ratios, nearly all belonging to reaction products with rather long half-lifes, were determined for the first time.

NUCLEAR PROPERTIES AND REACTIONS, A=59-89, THEORETICAL

NUCLEAR REACTIONS AND SCATTERING

38515 (ORNL-tr—4561) **Have shock waves been observed in nuclear collisions.** Gudima, K.K.; Toneev, V.D. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1977. Translation by S.D. Blalock Jr. of JINR—P2-10431. 20p. Dep. NTIS, PC A02/MF A01.

Experimental data on shock wave phenomena in nuclear reactions are analyzed within the kinetic theory rather than that of the hydrodynamic approach. Beginning with a presentation of the model, which is a generalization of the cascade—evaporation model to the case of the interaction of two nuclei, it is then ascertained to what degree the developed approach is valid. Next on the basis of this model the results of experiments performed are examined to find the effects of a shock wave. The results of this analysis and the related set-up of new experiments are discussed also. 34 references. (JFP)

NUCLEAR PROPERTIES AND REACTIONS, A=59-89, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 38514

38516 (CONF-780123—1) **Studies of evaporation residue products from krypton and argon reactions.** Plasil, F.; Ferguson, R.L.; Britt, H.C.; Erkkila, B.H.; Goldstone, P.D.; Stokes, R.H.; Blann, M.; Gutbrod, H.H. (Oak Ridge National Lab., Tenn. (USA); Los Alamos Scientific Lab., N.Mex. (USA); Rochester Univ., N.Y. (USA); California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 1978. Contract W-7405-ENG-26. 9p. Dep. NTIS, PC A02/MF A01.

From 6. workshop on gross properties of nuclei and nuclear excitations; Hirschegg, Austria (15 Jan 1978).

Mass distributions of evaporation residue (ER) products from ^{86}Kr-bombardments of ^{70}Ge and ^{74}Ge were obtained by a time-of-flight method at energies ranging from the interaction barrier to 706 MeV. ER excitation functions were also obtained for a variety of target and projectile combinations. Results are compared with statistical model calculations and with results obtained from γ-measurements. It is deduced that at the lowest impact parameters, the reaction products belong to the ER group, in contrast with the angular momentum hypothesis of Lefort. Cross sections were found to be consistent with an angular momentum limit arising from the onset of fission.

38517 Dissipation, mass exchange and the microscopic time scale of heavy-ion collisions. Schroeder, W.U.; Huizenga, J.R.; Birkelund, J.R. (Rochester Univ., N.Y. (USA). Dept. of Chemistry); Wolf, K.L.

(Argonne National Lab., Ill. (USA)); Viola, V.E. Jr. (Maryland Univ., College Park (USA). Dept. of Chemistry). *Phys. Lett., B;* 71: No. 2, 283-286(21 Nov 1977).

The time scale provided by the nucleon exchange mechanism in heavy-ion reactions is employed to study kinetic energy damping. The experimental kinetic energy lost per nucleon exchanged in Kr- and Xe-induced reactions is observed to decrease linearly with the total kinetic energy loss. These results, which are consistent with energy dissipation and nucleon exchange occurring on a similar time scale, are compared with the predictions of a one-body dissipation mechanism and a diffusion model.

NUCLEAR PROPERTIES AND REACTIONS, A=90-149, THEORETICAL

ENERGY LEVELS AND TRANSITIONS

38518 Deexcitation of compound nuclei with high angular momenta. Plasil, F. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., C;* 17: No. 2, 823-826(Feb 1978).

Effective excitation energies used to obtain level densities in statistical model deexcitation calculations of nuclei with high angular momenta have been evaluated specifically for neutron, proton, deuteron, and α emission. When particle emission is assumed to change the initial angular momentum distribution, the effect of these excitation energies is to strongly enhance α emission relative to other modes of deexcitation. Calculations are illustrated with reference to the deexcitation of the ^{149}Tb compound nucleus.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 38509, 38515

38519 (COO—3239-17) **Nuclear chemistry research of high-energy nuclear reactions at Carnegie-Mellon University, 1961—1977. Summary report.** Caretto, A.A. Jr. (Carnegie-Mellon Univ., Pittsburgh, Pa. (USA). Dept. of Chemistry). Nov 1977. Contract EY-76-S-02-3239. 27p. Dep. NTIS, PC A03/MF A01.

The activities and the results of research in the study of high energy nuclear reactions carried out at Carnegie Institute of Technology from 1957 to 1967 and at Carnegie-Mellon University from 1967 to 1977 are summarized. A complete list of all publications, doctoral dissertations, and reports resulting from the research of this project is also included. A major part of the report is a review of the research activities and results. The objective of the research of this project was the study of reactions initiated by projectiles of energy above about 100 MeV. The main effort was the investigation of simple nuclear reactions with the objective to deduce reaction mechanisms. These reactions were also used as probes to determine the nuclear structure of the target. In addition, a number of studies of spallation reactions were undertaken which included the determination of excitation functions and recoil properties. Recent research activities which have involved the study of pion induced reactions as well as reactions initiated by heavy ions is also discussed.

NUCLEAR PROPERTIES AND REACTIONS, A=90-149, EXPERIMENTAL

RADIOACTIVE DECAY

38520 Decay of mass-separated ^{143}Ba to levels in ^{143}La. Pacer, J.C.; Hill, J.C.; Shirk, D.G.; Talbert, W.L. Jr. (Ames Laboratory-ERDA and Department of Physics, Iowa State University, Ames, Iowa 50011). *Phys. Rev., C;* 17: No. 2, 710-717(Feb 1978).

The decay of mass-separated ^{143}Ba to levels in ^{143}La has been investigated using γ-ray spectroscopy in both the singles and coincidence modes. Of 69 γ rays ascribed to the decay of ^{143}Ba, 59 were placed in a level scheme which represents the first information on excited states in ^{143}La. A total of 19 levels up to a maximum energy of 2347 keV were observed. The resulting level scheme is compared with that of ^{141}La and systematics of odd-A La isotopes are discussed.

ENERGY LEVELS AND TRANSITIONS

38521 Gamma-ray linear polarization measurements in ^{129}Ba. Gizon, J.; Gizon, A.; Lee, Y.K.; Elliott, D.O. (Institut des Sciences Nucleaires (USMG), Grenoble, France). *Phys. Rev., C;* 17: No. 2, 596-600(Feb 1978).

The linear polarization of γ rays in ^{129}Ba produced by the reaction ^{120}Sn(^{12}C,3n) was measured using a Compton polarimeter made of two Ge(Li) coaxial detectors. The results establish unambiguously the h/sub 11/2/ band structure and its separation into the Omega-tilde = j = 11/2 and Omega-tilde = j - 1 = 9/2 level subsystems. The existence of the g/sub 7/2/ band is shown for the first time in the mass region A $\simeq$ 130.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 38514

38522 Angular-momentum effects in pre-equilibrium processes. Sarantites, D.G.; Westerberg, L.; Dayras, R.A.; Halbert, M.L.; Hensley, D.C.; Barker, J.H. (Department of Chemistry, Washington University, St. Louis, Missouri 63130). *Phys. Rev., C;* 17: No. 2, 601-621(Feb 1978).

Cross sections and the first three moments of the γ-ray multiplicity distribution were measured for many transitions corresponding to xn and xnα products from bombardments of ^{166}Er with ^{4}He, ^{150}Nd with ^{20}Ne, and ^{130}Te with ^{40}Ar. The ^{4}He and ^{20}Ne bombarding energies were chosen to produce ^{170}Yb compound nuclei at similar excitation energies, approximately 63, 77, and 92 MeV. A Ge(Li) -NaI anti-Compton spectrometer was used in coincidence with nine 5.1-cm by 7.6-cm NaI(Tl) detectors. For the reactions (^{20}Ne,xn) and (^{40}Ar,xn), the average γ-ray multiplicity <M>/sub x/ increases linearly with decreasing x as expected from the statistical decay of compound nuclei. In the (^{4}He,xn) reactions, <M>/sub x/ is similar for large x but for small x it decreases substantially with decreasing x. The latter corresponds to a shift in the population toward the low J values of levels in /sup 170-x/Yb prior to γ decay. Also, in the few-neutron channels the average multiplicity associated with a given gating transition in the residual nucleus is much smaller for transitions between low-lying levels. These features, absent in the heavy-ion bombardments, indicate a strong contribution from pre-equilibrium neutron emission. The measured (^{4}He,xn) cross sections are in reasonable agreement with those calculated from the geometry-dependent hybrid model of pre-equilibrium emission except for the smallest values of x; the latter results and the low <M>/sub x/ values for x < or = 4 suggest that more than one pre-equilibrium neutron is emitted in these channels.

NUCLEAR PROPERTIES AND REACTIONS, A=150-189, EXPERIMENTAL

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 38522

38523 Lifetime measurements and multiple Coulomb excitation in ^{162}Dy. Hubert, P.; Johnson, N.R.; Eichler, E. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., C;* 17: No. 2, 622-627(Feb 1978).

Rotational states up to spin 12^+ in ^{162}Dy have been Coulomb excited by 148.6 MeV $^{40}Ar^{8+}$ ions. The half-lives of the 4^+, 6^+, and 8^+ states were measured by the Doppler-shift recoil-distance method and were found to be 132 +- 6, 18.4 +- 1.0, and 4.6 +- 0.3 ps, respectively. In addition, relative Coulomb excitation probabilities up through the 12^+ member in the ground-state band were measured. All B(E2) values are in good agreement with rotational model expectations except for the 10^+ state, and within 2σ it is in agreement.

38524 Lifetimes of ground-band states in ^{150}Nd. Yates, S.W.; Johnson, N.R.; Riedinger, L.L.; Kahler, A.C. (Department of Chemistry, University of Kentucky, Lexington, Kentucky 40506). *Phys. Rev., C;* 17: No. 2, 634-638(Feb 1978).

Members of the ground-state band of ^{150}Nd to spin 8^+ have been Coulomb excited with 149-MeV ^{40}Ar ions, and the lifetimes of these states have been measured by the Doppler-shift recoil distance method. The half-lives of the 2^+, 4^+, 6^+, and 8^+ states are 1.44 +- 0.07 ns, 63.0 +- 3.2 ps, 12.4 +- 1.1 ps, and 4.0 +- 0.4 ps, respectively. The observed enhancement of the experimental B(E2)'s over rotational values is found to be in agreement with a simple band-mixing description.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 38514

38525 /sup 188,190,192/Os(t,p) reaction at 15 MeV. Flynn, E.R.; Burke, D.G. (University of California, Los Alamos Scientific Laboratory Los Alamos, New Mexico 87545). *Phys. Rev., C;* 17: No. 2, 501-507(Feb 1978).

A study of the heavier osmium isotopes ^{190}Os, ^{192}Os, and ^{194}Os has been made with the (t,p) reaction using a 15 MeV triton beam. The osmium nuclei may be considered as transitional nuclei going from a deformed to a spherical shape with increasing neutron

number and the (t,p) reaction is used to probe this change. The study principally investigates the position and strength of the 0^+ states, a number of new such states being observed. The nucleus ^{194}Os is also reported in some detail for the first time with 15 excited levels observed and 7 spin assignments made.

38526 **Neutron capture cross section of ^{159}Tb from 2.6 to 700 keV.** Mizumoto, M.; Macklin, R.L.; Halperin, J. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., C;* **17**: No. 2, 522-528(Feb 1978).

The ^{159}Tb(n,γ) cross section was measured using a neutron time of flight facility. The average capture cross section was deduced from 2.6 to 700 keV and in combination with recently reported transmission results, as well fitted with energy independent strength functions. Resonance parameters for many of the observed peaks from 2.6 to 3.4 keV were determined by a nonlinear least squares fitting program. The γ ray multiplicity for average capture was measured, giving the relatively low value, 2.45 +- 0.01 at 4 keV, implying a high proportion of two-step cascades. The fluctuations in the cross section about that computed from strength functions were analyzed. No significant nonrandom structure in the cross section was indicated.

NUCLEAR PROPERTIES AND REACTIONS, A=190-219, THEORETICAL

38527 **Thomas Fermi model of finite nuclei.** Boguta, J.; Rafelski, J. (Argonne National Lab., Ill. (USA)). *Phys. Lett., B;* **71**: No. 1, 22-26(7 Nov 1977).

A relativistic Thomas-Fermi model of finite-nuclei is considered. The effective nuclear interaction is mediated by exchanges of isoscalar scalar and vector mesons. The authors include also a self-interaction of the scalar meson field and the Coulomb repulsion of the protons. The parameters of the model are constrained by the average nuclear properties. The Thomas-Fermi equations are solved numerically for finite, stable nuclei. The particular case of $_{208}{}^{82}$Pb is considered in more detail.

RADIOACTIVE DECAY

38528 (LA—7197) **Estimating population sizes in a mixture of two radioactive populations.** Beyer, W.A.; Qualls, C. (Los Alamos Scientific Lab., N.Mex. (USA)). Apr 1978. Contract W-7405-ENG-36. 27p. Dep. NTIS, PC A03/MF A01.

The event times are observed of a mixture of two kinds of radioactive atoms, each producing alpha particles. The probability of observing an event is p, $0 < p < 1$, and of missing the observation is 1 - p. A maximum likelihood statistical method is given for estimating the size of the two populations. A second discussion assumes that the populations themselves are samples from parent populations. Bayesian methods are given for estimating parameters of the parent populations. An example is presented of an experiment involving the search for particle-bound polyneutron systems. 2 figures, 3 tables.

NUCLEAR REACTIONS AND SCATTERING

38529 (COO—3496-67) **Mechanisms of energy dissipation and nucleon exchange in damped reactions induced by very heavy ions.** Schroeder, W.U.; Huizenga, J.R.; Birkelund, J.R.; Wilcke, W. (Rochester Univ., N.Y. (USA)). 1978. Contract EY-76-S-02-3496. 5p. (CONF-780123—3). Dep. NTIS, PC A02/MF A01.

From 6. workshop on gross properties of nuclei and nuclear excitations; Hirschegg, Austria (15 Jan 1978).

Damped reactions induced by very heavy ions on heavy targets were studied. Strong correlations of experimental observables with the kinetic-energy loss suggest a continuous evolution of the reaction mechanism from quasi-elastic to strongly damped collisions. These correlations are employed to deduce experimental deflection functions, reaction times and transport coefficients for nucleon exchange. The time scale provided by the statistical nucleon exchange process is applied to study the energy dissipation mechanism in terms of a diffusion model and a one-body dissipation mechanism. The bombarding energy dependence of the experimental correlations is discussed.

38530 **Theoretical correlation between energy dissipation, angular momentum transfer, and charge diffusion in deep inelastic reactions.** Sventek, J.S.; Moretto, L.G. (Nuclear Science Division, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Phys. Rev. Lett.;* **40**: No. 11, 697-700(13 Mar 1978).

The Z dependence of the orbital angular momentum transferred into the intrinsic spins of deep-inelastic collisions partners is studied. The correlation between energy loss and nucleon transfer calculated by the present method is compared with that derived by previously proposed empirical methods. The currently used empirical approaches appear to be subject to serious systematic errors.

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 38525

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 38508, 38517

NUCLEAR PROPERTIES AND REACTIONS, A=220 AND ABOVE, EXPERIMENTAL

RADIOACTIVE DECAY

REFER ALSO TO CITATION(S) 38533

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 38531

NUCLEAR REACTIONS AND SCATTERING

38531 (COO—3496-68) **Nuclear properties of einsteinium and fermium.** Huizenga, J.R. (Rochester Univ., N.Y. (USA)). 1978. Contract EY-76-S-02-3496. 36p. (CONF-780123—2). Dep. NTIS, PC A03/MF A01.

From 6. workshop on gross properties of nuclei and nuclear excitations; Hirschegg, Austria (15 Jan 1978).

From the experiments which ended in the discovery of the elements einsteinium and fermium the properties of those elements are studied and described. The production, spontaneous fission, and ground state obitals are among the described characteristics. 18 references. (JFP)

38532 (UCRL—52000-77-7, pp 27-33) **Probing nuclei with LLL's electron linear accelerator.** Jul 1977.

In Energy and technology review.

Linear accelerators help expand understanding of basic nuclear phenomena. This understanding yields many benefits, such as design of superior nuclear weapons or to improvements vs. knowledge of materials for nuclear reactors. The LLL 100-MeV electron linear accelerator--linac--is used for a variety of applications, such as measuring neutron cross sections, producing gamma rays to make radioactive isotopes, and generating positrons for photonuclear experiments. 6 figures.

38533 (UCRL—80503) **Recent searches for superheavy elements at the superhilac.** Hulet, E.K. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 28 Mar 1978. Contract W-7405-ENG-48. 10p. (CONF-780333—3). Dep. NTIS, PC A02/MF A01.

From Symposium on superheavy elements; Lubbock, TX, USA (9 Mar 1978).

The results of the search for superheavy elements are negative with respect to the finding of such elements. However, by assuming 2 spontaneous fission events as the lower limit of detection, the limits to their formation cross sections are calculated and plotted. It is noted that the half-life limits, also shown are easily within the huge uncertainties of the theoretical predicted half lives for any superheavy element nuclides produced in the experiment. 19 references. (JFP)

SPONTANEOUS AND INDUCED FISSION

REFER ALSO TO CITATION(S) 38531

38534 (LA-UR—78-499) **Fission properties of einsteinium and fermium.** Hoffman, D.C. (Los Alamos Scientific Lab., N.Mex. (USA)). 1978. Contract W-7405-ENG-36. 14p. (CONF-780134—1). Dep. NTIS, PC A02/MF A01.

From Symposium commemorating the 25th anniversary of the discovery of elements 99 and 100; Berkeley, CA, USA (23 Jan 1978).

The systematics of the low energy fission of the fermium isotopes is studied considering half-lives, masss division, kinetic-energy release, and accompanying prompt neutron emission. It is shown that the low energy fission of the fermium isotopes is a microcosm of the fission process, exhibiting a wide range of half lives, mass and kinetic energy distributions and varying neutron emission. The trends in the fermium isotopes are considered. 23 references. (JFP)

38535 (UCRL—80624) **Stability of superheavy elements: rotation and internal excitation limits.** Mustafa, M.G. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 6 Mar 1978. Contract W-7405-ENG-48. 12p. (CONF-780333—1). Dep. NTIS, PC A02/MF A01.

From Symposium on superheavy elements; Lubbock, TX, USA (9 Mar 1978).

The rotation and internal excitation limits of stability of superheavy compound nuclei (formed, for example, by heavy-ion collisions) are studied. The work is based on a macroscopic-microscopic description of the deformation of a nucleus. The two-center shell model for fission is generalized to include rotation (microscopic description) and internal excitations (statistical description). The physical basis for this study is described and the calculated results of the stability of fission barriers of superheavy elements are presented.

38536 Angular distribution of fission fragments from fast fission of ^{235}U. Hsue, S.T. (Univ. of Michigan, Ann Arbor); Knoll, G.F.; Meadows, J. *Nucl. Sci. Eng.;* **66**: No. 1, 24-28(Apr 1978).

Measurements have been made of the angular distribution of fission fragments from ^{235}U at three fast-neutron energies. Results are fit by the expression $W(\theta) = 1 + A_2\cos^2\theta$, with the anisotropy factor, A_2, found to be -0.010 +- 0.014 at 265 keV, +0.137 +- 0.016 at 770 keV, and +0.157 +- 0.019 at 964 keV.

NUCLEAR THEORY

NUCLEAR STRUCTURE

38537 (CONF-780125—1) **Inelastic scattering and deformation parameters.** Ford, J.L.C. Jr. (Oak Ridge National Lab., Tenn. (USA)). 1978. Contract W-7405-ENG-26. 16p. Dep. NTIS, PC A02/MF A01.

From Symposium on nuclear physics; Oaxtepec, Mexico (3 Jan 1978).

In recent years there has been extensive study of nuclear shape parameters by electron scattering, μ meson atomic transitions, Coulomb excitation and direct nuclear inelastic scattering. Inelastic scattering of strongly absorbed particles, e.g., alpha-particles and heavy ions, at energies below and above the Coulomb barrier probe the charge and mass distributions within the nucleus. This paper summarizes measurements in this field performed at Oak Ridge National Laboratory.

38538 (ORNL—5054/R1) **Evaluated Nuclear Structure data file: a manual for preparation of data sets.** Ewbank, W.B.; Schmorak, M.R. (Oak Ridge National Lab., Tenn. (USA)). Feb 1978. Contract W-7405-ENG-26. 42p. Dep. NTIS, PC A03/MF A01.

A standard input format for nuclear structure data is described. The format is sufficiently structured that bulk data can be entered efficiently. At the same time, the structure is open-ended and can accommodate most measured or deduced quantities that yield nuclear structure information. (JFP)

38539 Semiclassical approximation for a momentum dependent one-body potential. Dworzecka, M.; Moszkowski, S.A. (University of Maryland, College Park, Maryland 20742). *Phys. Rev., C;* **17**: No. 2, 766-769(Feb 1978).

Recently a semiclassical approximation was applied by Jennings et al. for a system of noninteracting fermions in a local one body potential. This is a way to calculate shell corrections alternative to the Strutinski method. We have generalized this method to a spherical but a momentum dependent potential of the form $V(r) + 1/2[p^2W(r) + W(r)p^2]$. Explicit expressions are developed for the number of particles and the smoothed sum of single particle energies in terms of the Fermi energy and the one body potential and its first two derivatives. They are calculated for selected values of the parameters and compared with the sum of single particle energies obtained by numerical solution of the Schroedinger equation. The difference between the two is essentially the shell correction. The shell correction can be roughly estimated using a simple modification of the isotropic harmonic oscillator model.

38540 Explanation of near equality of isoscalar and electromagnetic transition rates in neutron-excess nuclei: comparison with data. Bernstein, A.M. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Physics); Brown, V.R.; Madsen, V.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). *Phys. Lett., B;* **71**: No. 1, 48-52(7 Nov 1977).

The ratios of isoscalar and electromagnetic transition rates to the lowest 2^+ state in neutron-excess nuclei are compared to predictions based on the ratios of isovector and isoscalar transition strengths determined from microscopic effective-charge theory in which giant-quadrupole core-polarization contributions are included with a schematic model. The near equality of the isoscalar (determined from (α, α')) and electromagnetic transition rates is explained, and it is shown that shell effects may be large but that they are compensated for in part by core-polarization effects. A comparison to data for single-closed-shell nuclei is consistent with the schematic-model prediction that the remaining shell effects are systematically different for neutron- versus proton-valence nuclei.

NUCLEAR MATTER

38541 Pion condensation and the region of stability of abnormal nuclei. Migdal, A.B.; Markin, O.A.; Mishustin, I.N.; Sorokin, G.A. (L. D. Landau Institute of Theoretical Physics, USSR Academy of Sciences). *Sov. Phys. - JETP (Engl. Transl.);* **45**: No. 4, 654-658(Apr 1977).

The possibility of the existence of superdense nuclei with various Z/A ratios is demonstrated. The equilibrium density and binding energy of abnormal nuclei are computed within the framework of simple models. It is shown that the accuracy of the theory at the present time is not sufficient to conclude definitely that there are such nuclei, but the possibility exists when reasonable nuclear constants are chosen.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 38464, 38466, 38537, 38546

38542 Convergence and the third-order effective shell-model interaction. Sandel, M.S.; McCarthy, R.J.; Barrett, B.R.; Vary, J.P. (Department of Physics, University of Arizona, Tucson, Arizona 85721). *Phys. Rev., C;* **17**: No. 2, 777-784(Feb 1978).

Several commonly made approximations in microscopic effective interaction calculations have been found to result in serious inaccuracies. Recent improved second-order calculations for A = 18 nuclei suggested somewhat better order by order convergence in the reaction matrix G than indicated previously. A selected third-order term has been calculated to study further this possibility. The convergence of the intermediate-state summation was also investigated for this diagram. Our improved calculational technique results in a greater reduction of the third-order term than the reduction found earlier for the second-order term. The outlook for the (asymptotic) convergence of the expansion is much improved, but the prospects for a complete third-order calculation of the effective interaction are dim due to the difficulties of the calculation.

38543 Dynamic polarization potential for heavy-ion scattering. Love, W.G.; Satchler, G.R. (Oak Ridge National Lab., Tenn. (USA)); Terasawa, T. (Tokyo Univ. (Japan). Coll. of General Education). *Nucl. Phys., A;* **291**: No. 1, 183-205(7 Nov 1977).

The effects of target and/or projectile excitation on the elastic scattering of heavy ions are studied. The results are cast in the form of contributions to both the real and imaginary parts of the ion-ion optical potential. In particular, a trivially 'equivalent' local potential (TELP) is found to simulate the effects of coupling to one or more open channels. Particular application is made to the dynamic polarization resulting from the long-range Coulomb potential. Comparison with coupled-channel calculations shows that the TELP can accurately reproduce these effects of Coulomb excitation. The correction to the absorptive potential is found to be much larger than that for the real potential. This correction is long-ranged and cannot be simulated by any reasonable adjustment of the usual Woods-Saxon form of potential. The TELP provides an alternative to performing coupled-channels calculations and may be particularly useful when reactions other than inelastic scattering are to be studied.

38544 Medium energy meson physics. Weise, W. (Univ., Regensburg, Ger.). *Acta Phys. Austriaca, Suppl.;* No. 18, 677-726(1977).

From XVI proceedings on contacts between high energy physics and other fields of physics; Schladming, Austria (24 Feb 1977).

See CONF-770257—.

A model of the elementary pion—nucleon interactions both on- and off-shell in order to study the pion nuclear many-body problem. As a testing ground for off-shell properties, pion absorption is used in a simple system like the deuteron. Pion condensation, scattering, and absorption are considered. The main purpose is to outline a common dynamical basis for the description of these phenomena. A very brief digression on kaon—nuclear interactions is also included. 53 references. (JFP)

38545 Quasi-free scattering and nuclear structure. Maris, T.A.J. (Universidade Federal do Rio Grande do Sul, Porto Alegre, Brasil). pp 425-457 of Nuclear and particle physics at intermediate energies. Warren, J.B. (ed.). New York; Plenum Press (1976).

From Proceedings of the advanced study institute in nuclear and particle physics at intermediate energies; Victoria, B.C., Canada (Jun 1975).

See CONF-7506100—.

A presentation is given of an overall review of the field of quasi-free scattering both the experimental situation and the main theoretical ideas. Also open or debatable problems are discussed leaving out detailed derivation of known formalism. 27 references. (JFP)

RADIOACTIVE DECAY

38546 (COO—3494-29) **Overlaid Alice: a statistical model computer code including fission and preequilibrium models.** Blann, M. (Rochester Univ., N.Y. (USA). Nuclear Structure Research Lab.; Bonn Univ. (Germany, F.R.); Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.)). 1976. Contract EY-76-S-02-3494. 70p. Dep. NTIS, PC A04/MF A01.

Includes additions and corrections (COO—3494-32). Portions of document are illegible.

The most recent edition of an evaporation code originally written previously with frequent updating and improvement. This version replaces the version Alice described previously. A brief summary is given of the types of calculations which can be done. A listing of the code and the results of several sample calculations are presented. (JFP)

SPONTANEOUS AND INDUCED FISSION

REFER ALSO TO CITATION(S) 38546

38547 **Modified one-body nuclear dissipation.** Sierk, A.J.; Koonin, S.E.; Nix, J.R. (Theoretical Division, Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Rev., C;* 17: No. 2, 646-653(Feb 1978).

We study a modification of the one-body dissipation mechanism for the conversion of energy of collective nuclear motion into internal single-particle excitation energy. One-body nuclear dissipation is a consequence of the long mean free path of nucleons inside a nucleus, and arises from nucleons colliding with the moving boundary of the nucleus rather than with other individual nucleons. In our modification, which attempts to incorporate self-consistency, the dissipation rate is proportional to an integral over the nuclear surface of the square of the normal component of the normal derivative of the velocity. The resulting properties of this dissipation are qualitatively similar to those of ordinary two-body viscosity rather than to those of the original one-body dissipation. In particular, for small oscillations about a sphere the dissipation rate increases with increasing multipole degree, and in fission this dissipation leads to more elongated scission shapes and to decreased fission-fragment kinetic energies. By adjusting the parameter that specifies the magnitude of this dissipation, we are able to reproduce adequately the experimental most probable fission-fragment kinetic energies for the fission of nuclei throughout the Periodic Table.

NUCLEAR MODELS

38548 **Algebraic approach to vibrational collective motion in a model with both collective and noncollective degrees of freedom.** Vassanji, M.G.; Klein, A.; Dasso, C. (Department of Physics, University of Pennsylvania, Philadelphia, Pennsylvania 19174). *Phys. Rev., C;* 17: No. 2, 755-765(Feb 1978).

An algebraic approach, within a framework using equations of motion, is applied to the study of vibrational collective motion in exactly soluble shell models with symmetry R(5) and R(5) +- R(5). The latter exhibits two phonon branches, permitting the study of the effect of the noncollective on the collective branch. The results of this method, including the splitting of the two-phonon degeneracy, agree satisfactorily with exact results for a range of parameters well into the transition region between vibrational and rotational motion.

RADIATION AND SHIELDING PHYSICS

RADIATION PHYSICS

REFER ALSO TO CITATION(S) 38337, 38398

SHIELDING CALCULATIONS AND EXPERIMENTS

38549 **Where are we and where are we going in reactor shielding.** Maienschein, F.C. (Oak Ridge National Lab., Tenn. (USA)). *Atomkernenergie;* 30: No. 4, 229-233(1977).

From 5. international reactor shielding conference; Knoxville, Tenn. (18 - 22 Apr 1977).

3 figs.; 15 refs.

We can note substantial recent progress in most all aspects of reactor shielding and we anticipate continued gains. Methods and data may tend to assume greater stability in the future although the expected concern with new reactor systems such as those based on fusion make this less likely. Recent problems with neutron streaming may aid in gaining consideration of shielding earlier in the reactor design process. A set of possible challenges in reactor shielding is given.

38550 **Shielding methods development in the United States.** Mynatt, F.R. (Oak Ridge National Lab., Tenn. (USA)). *Atomkernenergie;* 30: No. 4, 238-243(1977).

From 5. international reactor shielding conference; Knoxville, Tenn. (18 - 22 Apr 1977).

4 figs.; 15 refs.

A generalized shielding methodology has been developed in the USA that is adaptable to the shielding analyses of all reactor types. Thus far used primarily for liquid-metal fast breeder reactors, the methodology includes several component activities: 1) developing methods for calculating radiation transport through reactor-shield systems; 2) processing cross-section libraries; 3) performing design calculations for specific systems; 4) performing and analyzing pertinent integral experiments; 5) performing sensitivity studies on both the design calculations and the experimental analyses; and, finally, 6) calculating shield design parameters and their uncertainties. The criteria for the methodology are a 5 to 10% accuracy for responses at locations near the core and a factor of 2 accuracy for responses at distant locations. The methodology has been successfully adapted to most in-vessel and ex-vessel problems encountered in the shield analyses of the Fast Flux Test Facility and the Clinch River Breeder Reactor; however, improved techniques are needed for calculating regions in which radiation streaming is dominant. Areas of the methodology in which significant progress has recently been made are those involving the development of cross-section libraries, sensitivity analysis methods, and transport codes.

NEUTRON INTERACTIONS WITH MATTER

38551 (LA—7191-MS) **Differences between LASL- and ANL-processed cross sections.** Kidman, R.B.; MacFarlane, R.E.; Becker, M. (Los Alamos Scientific Lab., N.Mex. (USA)). Mar 1978. Contract W-7405-ENG-36. 164p. Dep. NTIS, PC A08/MF A01.

As part of the Los Alamos Scientific Laboratory (LASL) cross-section processing development, LASL cross sections and results from MINX/1DX system are compared to the Argonne National Laboratory cross sections and results from the ETOE-2/MC^2-2 system for a simple reactor problem. Exact perturbation theory is used to establish the eigenvalue effect of every isotope group cross-section difference. Cross sections, cross-section differences, and their eigenvalue effects are clearly and conveniently displayed and compared on a group-by-group basis.

38552 (ORNL/TM—6378) **Analytical calculations of neutron slowing down and transport in the constant-cross-section problem.** Cacuci, D.G. (Oak Ridge National Lab., Tenn. (USA)). Apr 1978. Contract W-7405-ENG-26. 264p. Dep. NTIS, PC A12/MF A01.

Thesis. Submitted to Columbia Univ., New York.

Aspects of the problem of neutron slowing down and transport in an infinite medium consisting of a single nuclide that scatters elastically and isotropically and has energy-independent cross sections were investigated. The method of singular eigenfunctions was applied to the Boltzmann Equation governing the Laplace transform (with respect to the lethargy variable) of the neutron flux. A new sufficient condition for the convergence of the coefficients of the expansion of the scattering kernel in Legendre polynomials was rigorously derived for this energy-dependent problem. Formulas were obtained for the lethargy-dependent spatial moments of the scalar flux that are valid for medium to large lethargies. Use was made of the well-known connection between the spatial moments of the Laplace-transformed scalar flux and the moments of the flux in the "eigenvalue space." The calculations were aided by the construction of a closed general expression for these "eigenvalue space" moments. Extensive use was also made of the methods of combinatorial analysis and of computer evaluation of complicated sequences of manipulations. For the case of no absorption it was possible to obtain for materials of any atomic weight explicit corrections to the age-theory formulas for the spatial moments M/sub 2n/(u) of the scalar flux that are valid through terms of the order of u^{-5}. The evaluation of the coefficients of the powers of n, as explicit functions of the nuclear mass, represent one of the end products of this investigation. In addition, an exact expression for the second spatial moment, $M_2(u)$, valid for arbitrary (constant) absorption, was derived. It is now possible to calculate analytically and rigorously the "age" for the constant-cross-section problem for arbitrary (constant) absorption and nuclear mass. 5 figures, 1 table.

38553 **Semi-analytic solution to the transport equation in spherical geometry.** Dubi, A.; Horowitz, Y.S. (Ben-Gurion Univ. of the Negev, Beersheva, Israel). *Nucl. Sci. Eng.;* 66: No. 1, 118-121(Apr 1978).

A semi-analytic method of solving the neutron transport problem for a homogeneous scattering and absorbing sphere with an isotropic central point source is described. The method consists essentially of a modified Neumann series approach in which the Neumann series is constructed for the difference between the finite problem and the closely related problem in infinite geometry.

38554 Polarization of neutrons that pass through a magnetized doubly bent neutron guide. Stepanov, S.S.; Zelenyuk, F.M. (Moscow Engineering Physics Institute). *Sov. Phys. - JETP (Engl. Transl.);* **45**: No. 4, 651-653(Apr 1977).

A method is described for obtaining polarized neutrons by passage through a magnetized doubly bent neutron guide made of the ferromagnetic alloy 50/sup N/ (50% Fe-50% Ni). Attention is called to the fact that such a neutron guide polarizes the neutrons effectively in a certain wavelength band, even though the magnetic scattering amplitude a/sub m/ is several times smaller than the nuclear amplitude a/sub n/. The degree of polarization in this band is equal to 0.85 +- 0.04.

38555 Direct-coupled-ray method for three-dimensional shielding analysis. Bucholz, J.A. (Union Carbide Corp., Oak Ridge, Tenn. (USA). Nuclear Div.; Oak Ridge National Lab., Tenn. (USA)). *Atomkernenergie;* **30**: No. 4, 313-316(1977).

From 5. international reactor shielding conference; Knoxville, Tenn. (18 - 22 Apr 1977).

7 figs.; 4 refs.

A fast, three-dimensional design-oriented transport method has been developed for the solution of both neutron and gamma shielding problems. It combines a nodal approach with analytic integral transport to achieve relative speed and accuracy.

MEDICAL PHYSICS

DOSIMETRY

REFER ALSO TO CITATION(S) 38236

38556 Letter to the Editor. Wells, A.H. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Med. Phys.;* **5**: No. 3, 235(May 1978).

An error in the Nucleon-Meson Transport Code of ORNL is noted.

38557 Microdosimetric measurements of ionization by monoenergetic photons. Kliauga, P.; Dvorak, R. (Columbia Univ., New York). *Radiat. Res.;* **73**: No. 1, 1-20(Jan 1978).

Microdosimetric event distributions for monoenergetic photons at eight primary photon energies between 12 and 1250 keV have been determined from measurements of ionization with a wall-less proportional counter. Event spectra were taken at simulated cavity diameters of 0.24, 0.48, 0.96, 1.9, 3.9, and 7.7 μm. Distributions of dose in lineal energy density, the microdosimetric equivalent of LET, are displayed as functions of site diameter and photon energy. The frequency mean and dose mean of lineal energy density are calculated and their behavior as a function of primary photon energy is discussed and compared with elementary theoretical predictions. Our results are consistent with previous microdosimetric measurements of photon radiation, and in agreement with the limited theoretical analysis available.

SOLID STATE PHYSICS

REFER ALSO TO CITATION(S) 37668, 37688

38558 (CONF-770913—8) Microscopic theory of charges density wave instability in $NbSe_2$. Das, S.G.; Sinha, S.K.; Wakabayashi, N. (Argonne National Lab., Ill. (USA); Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-31-109-ENG-38. 14p. Dep. NTIS, PC A02/MF A01.

From International conference on lattice dynamics; Paris, France (5 Sep 1977).

The microscopic theory of Sinha and Harmon for electronically driven lattice instabilities is used to explain the "Kohn-like" anomalies in the Σ_1 phonon branch and the observed incommensurate superlattice Bragg peak in 2H-$NbSe_2$, characteristic of the charge density wave at low temperatures in the neutron scattering experiments of Moncton et al. In accordance with the APW and LCAO band-structure calculations of Mattheiss of 2H-$NbSe_2$, the presence of three narrow d bands of atomic symmetry xy, x^2-y^2 and $3z^2$-r^2 at the Fermi level is assumed. Thus the conduction-band wave function is represented by a linear combination of tight-binding Gaussian atomic orbitals with neglect of the variation of the radial wave function across the bands. The screened electron-ion interaction and the Coulomb energy of the charge fluctuation on the d shells of Nb atoms is represented by a pseudopotential screened by the Lindhard dielectric function. The phonon eigenvectors needed for estimating the electron-phonon interaction were calculated using a simple force constant model. In agreement with the experimental results, it was found that the phonon frequencies for the Σ_1 and Σ_3 branches are very strongly renormalized as one approaches the zone boundary. By introducing the electronic relaxation effects a central peak appears at the q vector of the instability and the actual phonon renormalization is partially suppressed. This explains the superlattice Bragg peaks observed at low temperatures and "Kohn-like" anomalies in the Σ_1 phonon branch of $NbSe_2$.

SUPERCONDUCTIVITY

GENERAL THEORY

REFER ALSO TO CITATION(S) 38489

38559 Properties of a quasi-one-dimensional system below the superconducting transition temperature. Firsov, Y.A.; Yashin, G.Y. (A. F. Ioffe Physico-Technical Institute, Academy of Sciences of the USSR). *Sov. Phys. - JETP (Engl. Transl.);* **45**: No. 4, 761-769(Apr 1977).

We study the superconducting properties of a quasi-one-dimensional model which is a system of periodically spaced parallel metal filaments whose superconducting phases are linked directly through non-stationary Josephson junctions. We assume that the filaments are not too thin: $\xi >> d >> a$, where d is the filament diameter, a the lattice constant of the metal, and ξ the coherence length of the bulk metal. We study the behavior of the correlation functions, elucidate some features of ODLRO and discuss the specific features of a phase transition in such a quasi-one-dimensional system. We study the Meissner effect in such a system and show that it cannot be described by a trivial generalization of the Meissner equations to the anisotropic case. The dependence of the critical temperature T/sub k/ on the transverse resonance integral J/sub perpendicular/ (which characterizes the tunneling rate of the electrons from filament to filament) which was found earlier by Larkin and Efetov when T/sub k/ is approached from above (i.e., from the region where the phases in the different filaments are uncorrelated, and the phase system behaves as a one-dimensional one) is in the present paper cofirmed by approaching T/sub k/ from below (i.e., from the region where the system is essentially quasi-one-dimensional).

38560 Electron-phonon interaction in one-dimensional systems in the adiabatic approximation. Krivnov, V.Y.; Ovchinnikov, A.A. (L. Ya. Karpov Physico-chemical Research Institute). *Sov. Phys. - JETP (Engl. Transl.);* **45**: No. 4, 818-823(Apr 1977).

A one-dimensional Fermi gas interacting with lattice vibrations is considered in the adiabatic approximation. It is shown that the system should be a superconductor at small electron-phonon coupling constants g^2, in accord with the results of Froehlich. The critical velocity at which the superconducting state is stable with respect to scattering by impurities is found. The extreme case of large values of g^2 is investigated, and it is shown that in this case the problem reduces to the analysis of a system of almost noninteracting polarons. It is also shown that for the lattice Fermi gas the ground state corresponds to the Peierls state with a deformed lattice, and that the system is a dielectric.

ACOUSTIC, ELECTRIC, MAGNETIC, OPTICAL, AND THERMAL PHENOMENA

REFER ALSO TO CITATION(S) 37731

THEORETICAL PHYSICS

CLASSICAL AND QUANTUM MECHANICS

REFER ALSO TO CITATION(S) 38490, 38491

38561 Analyticity of the charge-monopole scattering amplitude. Balachandran, A.P.; Borchardt, S.; Chang, S.S.; Stern, A.; Cahalan, R.; Ramachandran, R.; Rupertsberger, H. (Physics Department, Syracuse University, Syracuse, New York 13210, and Center for Theoretical Studies, Indian Institute of Science, Bangalore, 560012, India.). *Phys. Rev., D;* **17**: No. 4, 1150-1154(15 Feb 1978).

We study the analyticity in $\cos\theta$ of the exact quantum-mechanical electric-charge-magnetic-monopole scattering amplitude by ascribing meaning to its formally divergent partial-wave expansion as the boundary value of an analytic function. This permits us to find an integral representation for the amplitude which displays its analytic structure. On the physical sheet we find only a branch-point singularity in the forward direction, while on each of the infinitely many unphysical sheets we find a logarithmic branch-point singularity in the backward direction as well as the same forward structure.

RELATIVITY AND GRAVITATION

38562 Introduction of canonical variables in the hydrodynamic equations of an ideal liquid in the general theory of relativity. Goncharov, V.P.; Kasil'nikov, V.A.; Pavlov, V.I. (M. V. Lomonosov Moscow State University). *Sov. Phys. - Dokl. (Engl. Transl.);* **22**: No. 9, 495-497(Sep 1977).

The hamiltonian is calculated for an ideal gravitating liquid with relativistic effects taken into account.

38563 Propagation of weak waves in a strong electromagnetic wave. Dinariev, O.Y.; Sibgatullin, N.R. (Moscow State University). *Sov. Phys. - JETP (Engl. Transl.);* **45**: No. 4, 645-650(Apr 1977).

The interaction of plane electromagnetic waves and gravitational waves is investigated. It is proved on the basis of the Einstein-Maxwell equations that an empty space-time that admits of an isotropic absolutely parallel Killing field, is described by the Peres solution. The equations for small perturbations of the gravitational and electromagnetic fields against the background of a strong plane electromagnetic wave are examined in the Newman-Penrose formalism. These equations are reduced to a system of two second-order equations relative to the tetrad components of the Weyl tensor Psi_0 and the Maxwell tensor F_0. Explicit solutions are obtained for the cases when weak plane gravitational and electromagnetic waves are incident on a strong wave.

OPTICS

38564 Angular distribution of synchrotron-Cerenkov radiation. Rynne, T.M.; Baumgartner, G.B.; Erber, T. (Department of Physics, Illinois Institute of Technology, Chicago, Illinois 60616). *J. Appl. Phys.;* **49**: No. 4, 2233-2240(Apr 1978).

High-energy charged particles emit synchrotron-Cerenkov radiation under the joint action of external magnetic fields and ambient media. The angular and spectral characteristics of this radiation have been derived by classical and quantum-mechanical methods. The experimental significance of the angular distribution: particularly features associated with striations: are considered in some detail.

38565 Adjoint Monte Carlo treatment of the equations of radiative transfer for polarized light. Carter, L.L.; Horak, H.G.; Sandford II, M.T. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87544). *J. Comput. Phys.;* **26**: No. 2, 119-138(Feb 1978).

The equation of radiative transfer for a Stokes' intensity vector is used to define a four-vector Green's function. The physical quantities of interest are represented by a response vector which is found by integrating the product of a suitable response matrix and the Stokes' intensity vector over phase space. Equations adjoint to those for the Stokes' intensity vector and for the Green's function vector are given. The response vector is then expressed in terms of the adjoint vector Green's function. A Monte Carlo sampling procedure is given by a Dirac delta function in phase space, the response vector is the Stokes' intensity vector and the "backward Monte Carlo method" of Collins and Wells (Report RRA-T74, Radiation Research Associates, Inc.) obtains.

MATHEMATICAL PHYSICS

38566 Solution of a modified Lame equation with an integral term. Hagelstein, P.L. (Research Laboratory of Electronics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *J. Math. Phys. (N.Y.);* **19**: No. 6, 1386-1390(Jun 1978).

We consider an equation which occurs in the stability analysis of a passively modelocked laser system in which the pulses overlap. The equation is related to a Lame equation and can be written su(x) $=\{d^2/dx^2-[(2-m)-6dn^2(x,m)]\}u(x)$ -$\epsilon\int$/sup() Km//sub() -Km/ u(x')dn(x',m)dx' $(1+\nu^2 d^2/dx^2)dn(x,m)$, where s is an eigenvalue and ϵ and ν are arbitrary parameters which need not be small. The eigenfunctions satisfy periodic boundary conditions $u(x+2K(m))=u(x)$. The eigenvalue s is proportional to the rate of growth of perturbations of the steady state pulse, and so we focus on finding the conditions under which no eigenvalue s is positive. We find that $\epsilon=2/\{\xi(m)-\nu^2[2E(m)-(2-m)\xi(m)]\}$ marks the stability boundary, where E(m) is the elliptic integral of the second kind and $\xi(m)$ is a function defined within the paper. This result is exact.

38567 Boundary conditions for multistep finite-difference methods for time-dependent equations. Gottlieb, D.; Turkel, E. (Institute for Computer Applications in Science and Engineering, NASA Langley Research Center, Hampton, Virginia 23665). *J. Comput. Phys.;* **26**: No. 2, 181-196(Feb 1978).

The stability and accuracy of various boundary treatments are analyzed for the two-step Richtmyer and MacCormack methods. Special attention is paid to ways of imposing the extra boundary conditions after the first step of the two-step process. The theory of Kreiss is used to study stability properties for both scalar and vector equations. The theory of Kreiss is used to study stability properties for both scalar and vector equations. The theory of Skollermo is used to compare accuracies of the various methods. Computations were also performed on both wavelike equations and on systems that approach a steady state. Several suggestions are given for more reliable boundary treatments.

FUSION ENERGY

38568 Technology index for plasmaphysics research and fusion reactors. Volume 11, No. 11, 1977. Bibliography, author index, subject index, appendix. Leopoldshafen, Ger.; Zentralstelle fuer Atomkernenergie-Dokumentation (1977). 61p.

This bibliography contains 272 references to various research work on plasma physics and controlled fusion. Subject and author indexes are included.

PLASMA RESEARCH

PLASMA CONFINEMENT AND HEATING

REFER ALSO TO CITATION(S) 38695

38569 (IAE—2610) Prospects for using electron-cyclotron waves for plasma heating in large tokamak facilities. Alikaev, V.V.; Dnestrovskii, Yu.N.; Parail, V.V.; Pereverzev, G.V. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1976. 27p. (In Russian). Dep. NTIS (US Sales Only), PC A03/MF A01.

A possibility of applying electron-cyclotron waves for plasma heating in large-scale installations of the "tokamak" type is considered. It has been shown that the wave damping at correctly chosen direction of the wave input into a plasma occurs mainly in the centre of the plasma column and spends on heating of the most part of electrons.

38570 (IPPJ-T—26) Notes on digital analysis of random signals. Amagishi, Y. (Nagoya Univ. (Japan). Inst. of Plasma Physics). Nov 1976. 12p. Dep. NTIS (US Sales Only), PC A02/MF A01.

A method of analyzing digitized random signals is described. We estimate power spectrum and/or phase velocity of transient signals from, for example, a turbulent heating plasma, assuming the signals are stationary in the sense of probability theory.

38571 (PPPL—1429) Stochastic ion heating by a lower hybrid wave. Karney, C.F.F. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Apr 1978. Contract EY-76-C-02-3073. 56p. Dep. NTIS, PC A04/MF A01.

The motion of an ion in a lower hybrid wave in a tokamak type plasma is studied. For ions with ν/sub perpendicular to/ approximately greater than ω/k/sub perpendicular to/ the motion is stochastic for fields satisfying E/B_0 greater than $^1/_4$ (Ω/sub i//ω)/ sup $^1/_3$/(ω/k/sub perpendicular to/). Provided the perpendicular phase velocity, ω/k/sub perpendicular to/, can be slowed down to a few times the ion thermal speed, this stochastic ion motion may be an important mechanism by which injected rf power near the lower hybrid frequency can directly heat the ions.

38572 Synchrotron-like radiation from intense laser beams in dense plasmas. Waltz, R.E.; Manley, O.P. (General Atomics Company, San Diego, California 92138). *Phys. Fluids;* **21**: No. 5, 808-813(May 1978).

It is shown that when an intense, focused laser beam interacts with a dense plasma, relativistic effects may lead to observable synchrotron-like x-ray emission. For currently achievable Nd:glass laser intensities, the detectability of 10 keV x rays is expected to be enhanced by anisotropy of the source and by strong polarization.

38573 Mode mixing of large scale fluctuations in JFT-2 tokamak. Odajima, K.; Wakatani, M.; Maeno, M.; Fujisawa, N. (Division of Thermonuclear Fusion Research, Japan Atomic Energy Research Institute, Tokai, Ibaraki, Japan). *Phys. Fluids;* **21**: No. 5, 846-851(May 1978).

Low frequency fluctuations in the JFT-2 tokamak are investigated. The fluctuations propagate in the direction of the electron diamagnetic drift velocity and have a toroidal mode number n=1. Density fluctuations reveal that the m=2 mode is dominant; on the other hand, magnetic field fluctuations show a poloidal mode number m=3. The apparent discrepancy is explained by a sum of m=2, m=3, and/or m=4 modes. Theoretical analysis based on the

magnetohydrodynamic theory of kink and tearing modes agrees well with experimental observations.

38574 Re-analysis of exponential rigid-rotor astron equilibria. Lovelace, R.V.; Larrabee, D.A.; Fleischmann, H.H. (School of Applied and Engineering Physics, Cornell University, Ithaca, New York 14853). *Phys. Fluids;* **21**: No. 5, 863-864(May 1978).

Previous studies of exponential rigid-rotor astron equilibria include particles which are not trapped in the self-field of the configuration. The modification of these studies required to exclude untrapped particles is derived.

38575 Ion turbulence in a CO_2-laser-plasma interaction experiment. Offenberger, A.A.; Ng, A.; Pitt, L. (Department of Electrical Engineering, University of Alberta, Edmonton, Canada). *Phys. Rev. Lett.;* **40**: No. 13, 873-875(27 Mar 1978).

Ruby-laser Thomson scattering have been used to measure ion density fluctuations in a CO_2-laser-heated gas-target plasma. Nonthermal enhancement of $> 10^4$ have been observed for kλ/sub D/ $\sim$ 0.5 implying δn/n $>$ 0.1. Ion fluctuations of this magnitude may be giving rise to enhanced absorption of laser radiation in the plasma.

38576 Fast-ion emission and resonance absorption in laser-generated plasma. Waegli, P.; Donaldson, T.P. (Institute of Applied Physics, University of Berne, CH-3021-Berne, Switzerland). *Phys. Rev. Lett.;* **40**: No. 13, 875-879(27 Mar 1978).

Plasma was generated by focusing a 35-psec, 1.06-μm laser onto Perspex. Ion expansion characteristics were measured relative to laser polarization and incidence angle. Thermal and "fast" ions were always seen. For optimum resonance absorption conditions the thermal ion energy increased, and a second faster-ion group appeared. Comparison with a computer code showed that the faster ions originated from electron acceleration by a intense electrostatic field.

38577 Comment on "Rapid thermal transport from a turbulent skin layer to plasma core in a toroidal experiment". Gentle, K.W. (Fusion Research Center, The University of Texas at Austin, Austin, Texas 78712). *Phys. Rev., A;* **17**: No. 3, 1222-1223(Mar 1978).

The observations of magnetic fields as a function of position and time during a pulse reported in a recent Letter by Nishida, Hirose, and Skarsgard imply turbulent heating substantially less than that inferred from the diamagnetic signals. The inferences of heating and penetration are therefore doubtful.

38578 Closed theta pinch balanced by a transverse current. Shneerson, G.A. *Sov. Tech. Phys. Lett. (Engl. Transl.);* **3**: No. 9, 385-386(Sep 1977).

The equilibrium properties are calculated.For a toroidal theta pinch with a curvilinear plasma axis.

38579 Certain features of flute perturbations in an open system with a radial electric field. Bekhtenev, A.A.; Volosov, V.I. (Institute of Nuclear Physics, Siberian Branch, Academy of Sciences of the USSR, Novosibirsk). *Sov. Phys. - Tech. Phys. (Engl. Transl.);* **22**: No. 7, 834-840(Jul 1977).

Flute perturbations in an open confinement system are analyzed for the case in which there is a radial electric field and for values βvery-much-less-than1. Under certain conditions these flute perturbations can be suppressed. These conditions are found. Effects due to the finite ion Larmor radius, the gradients of the radial electric field E(r), and the longitudinal currents in the plasma, are taken into account.

38580 Spectrum of electrons interacting with a strong ion-sound turbulence. Livshitz, M.A.; Tomozov, V.M.; Fedoryuk, M.V.; Tsytovich, V.N. (Institute of Terrestrial Magnetism, Ionosphere, and Radiowave Propagation, Siberian Division, USSR Academy of Sciences). *Sov. Phys. - JETP (Engl. Transl.);* **45**: No. 4, 743-748(Apr 1977).

Heating of electrons in a plasma by resonant ion-sound oscillations is considered under conditions when the effective turbulent collision frequency exceeds the frequency of the ion-sound oscillations, ν/sub eff/>kv/sub Te/(m/sub e//m/sub i/)/sup 1/2/. It is shown that under these conditions the plasma heating cannot be described in the weak-turbulence approximation. A collision integral that describes the heating under conditions of strong ion-sound turbulence is obtained. It is found that the stationary solutions of the equation for the regular part of the electron distribution function Phi exist for sufficiently wide spectra of the ion-sound oscillations and have a power-law dependence on the particle velocity v (or on the energy mv²/2).

38581 Dynamical behavior of a mirror-confined plasma. Galbraith, D.L. Ann Arbor, MI; Univ. of Michigan (1977). 140p. University Microfilms Order No. 77-26,242.

Thesis (Ph. D.).

The dynamic equations (particle and energy balance) for a mirror-confined plasma are presented, and calculational formulas are given for several of the quantities appearing therein. An isotropic, non-Maxwellian distribution function is assumed for the positive ions, and the calculation of its parameters is described. Formulas are derived, based upon binary collision theory, for clculating the particle and energy confinement of positive ions, the energy exchange rate between species, and the sigma-vee average using this assumed distribution function. The set of balance equations is then solved for an equilibrium condition. This equilibrium depends upon the reactor parameters supplied: mirror ratio, magnetic field strength, reactor size, injection energy and injection angle of the fuel ions, and the ratio of plasma to magnetic pressures. The results of the present calculation are compared to the results of a much more expensive Fokker-Planck calculation and it is found that for the most important quantities the values obtained are similar. There is, however, a wide discrepancy in the values found for most quantities associated with the alpha particles. This discrepancy is apparently caused by the failure of the present calculation to properly include the "suprathermal" slowing-down alphas in the overall alpha population. The results of a parameter study are presented graphically. This parameter study involved varying each of the input parameters (listed above) in turn about its "Reference Case" value, and observing the resultant change in value of a number of physical quantities associated with the plasma. The quantities considered are the confinement parameter, (N tau)/sub e/, the burnup fraction, the fusion power density, the Q ratio for the plasma, the average fuel ion energy, the plasma potential, and the thermal stability time constant.

38582 Plasma heating by a relativistic electron beam: an experimental study. Greenspan, M.A. Ithaca, NY; Cornell Univ. (1977). 289p. University Microfilms Order No. 77-28,379.

Thesis (Ph. D.).

A relativistic electron beam (350 kV, 3—20 kA), emitted over a 20 cm^2 cathode area, is injected through an anode foil into a highly ionized, mirror confined, hydrogen plasma column with a density (averaged over the beam cross sectional area) which could be varied from (n/sub p/) = 3 x $10^{11}/cm^3$ to 2 x $10^{13}/cm^3$. Experiments were conducted to systematically measure the plasma heating achieved as a function of plasma density, beam current, and beam velocity scatter (created in the anode foil). Further experiments were performed to study the heating mechanism.

PLASMA DIAGNOSTICS

REFER ALSO TO CITATION(S) 38689

38583 (FUPH-R—145) **Investigation of the composition of a hydrogen plasma using magnetoacoustic oscillations.** Brennan, M.H.; Jessup, B.L.; Jones, I.R. (Flinders Univ. of South Australia, Bedford Park. School of Physical Sciences). Oct 1977. 23p. Dep. NTIS (US Sales Only), PC A03/MF A01.

This paper reports on the use of observations of magnetoacoustic oscillations to determine the radial particle density and temperature profiles in a hydrogen plasma. The observations comprise measurements, at a number of frequencies, of the radial variations of the oscillation amplitude and of the total flux in the plasma. The analysis allows the accurate determination of radial profiles of the ion and atom number densities. It permits the inclusion of molecules in the discharge and the results are consistent with the assumption that no particles are lost to the walls of the discharge vessel during the lifetime of the plasma.

38584 (UCRL—52000-77-10, pp 19-23) **Dissector—restorer framing tube for recording very fast experiments.** Kalibjian, R. Oct 1977.

In Energy and technology review.

The dissector—restorer framing tube developed by our Electrical Engineering Department will aid scientists studying phenomena in very fast plasma experiments. This new framing tube dissects a continuous image and restores the dissected portion as a framed image. Our prototype forms three framed images in series, each with a frame period of about 100 ps. A photocathode version is now under construction for use in the laser fusion program to study laser-generated plasmas.

38585 Observation of electron-neutral inverse bremsstrahlung in an electron-beam-sustained discharge. Alroy, S.; Christiansen, W.H. (University of Washington, Seattle, Washington 98195). *Appl. Phys. Lett.;* **32**: No. 10, 607-609(15 May 1978).

The absorption of 10.6-μ and 2.8-μ radiation by inverse bremsstrahlung in an electron-beam-sustained discharge is measured in several gases as a function of E/N. The experimentally derived absorption cross sections are compared with theoretical predictions and good agreement is shown.

38586 Space-charge effects on particle diagnostics of laser-produced plasmas. Gitomer, S.J.; Brysk, H. (University of California,

Laser Division, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Appl. Phys. Lett.;* **32**: No. 10, 616-618(15 May 1978).

We have considered the interaction between a laser-produced plasma and a grounded conducting cylindrical aperture. Space-charge effects both within and beyond the aperture are treated in an approximate analysis. We apply our results to recent ion pinhole measurements to show that space-charge effects can account for the data obtained.

38587 Depolarization in laser probing of inhomogeneous magnetized plasmas. Lehmberg, R.H.; Stamper, J.A. (Naval Research Laboratory, Washington, D. C. 20375). *Phys. Fluids;* **21**: No. 5, 814-816(May 1978).

Density gradients and magnetic fields transverse to the propagation direction can produce polarization dependent phase shifts in a laser probing beam used for Faraday rotation studies of longitudinal magnetic fields in plasmas. The resulting depolarization should be considered when probing with fast optics near the critical density.

38588 Two-dimensional spectral line emission reconstruction as a plasma diagnostic. Myers, B.R.; Levine, M.A. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Rev. Sci. Instrum.;* **49**: No. 5, 610-616(May 1978).

A technique for reconstructing point-by-point light emission from a plasma using a series of one-dimensional, line-of-sight measurements is described. The method, an adaptation of tomographic x-ray scans, does not assume any symmetry in the plasma, unlike an Abel inversion. Results from the Tormac IV toroidal bicusp device are presented, in which plasma light was collected by a 16-channel polychromator with 0.4-A resolution and a 1-μs time response. Reconstructed plasma light emission with spatial, temporal, and wavelength resolution is then calculated. The profiles of reconstructed spectral lines (Stark broadened H/sub β/and Doppler broadened He ii 4686-A lines from the 90% H, 10% He plasma) are used to monitor local plasma density and temperature. A spatial resolution of 2 cm in a 14 x 24 cm vessel, which is determined by the number of angles that the plasma is viewed from, is realized. This technique is particularly useful when a high-temperature plasma is surrounded and obscured by a low-temperature, highly emissive plasma near the vessel walls.

38589 Heterodyne quadrature interferometer for simultaneous measurements of plasma density along several chords. Jacobson, A.R. (Los Alamos Scientific Laboratory, University of California, P. O. Box 1663, Los Alamos, New Mexico 87545). *Rev. Sci. Instrum.;* **49**: No. 5, 673-674(May 1978).

An interferometer has been developed with which it is possible to make simultaneous measurements of plasma density along several chords. A single Bragg cell and laser are used, and the phase detection is in quadrature in order to obtain unambiguous and uniformly sensitive readings.

38590 Stimulated Brillouin backscatter detection from a θ-pinch plasma. Armstrong, W.T. (Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *J. Appl. Phys.;* **49**: No. 4, 2566-2568(Apr 1978).

Detection of prompt stimulated Brillouin backscatter is reported from an experiment in which a high-power pulsed CO_2 laser irradiates an independently produced θ-pinch plasma. Analysis of the backscatter signal indicates that significant SBS gain is limited to a time period near peak incident power. The restriction on SBS gain is attributed to a varying temperature gradient.

38591 Macroscopic-particle diagnostics of hot plasmas. Golant, V.E.; Zhilinskii, A.P.; Kuteev, B.V.; Rozhanskii, V.A.; Sakharov, I.E.; Tsendin, L.D. (A. F. Ioffe Physicotechnical Institute, Academy of Sciences of the USSR, Leningrad). *Sov. Tech. Phys. Lett. (Engl. Transl.);* **3**: No. 10, 424-426(Oct 1977).

It is proposed that the motion of impurity ions can be used as a plasma diagnostic method for tokamak devices.

38592 Diagnostics of a beam plasma system with a two-electrode probe. Bakhrakh, L.E.; Zolotarev, E.L.; Murzin, V.V. (Saratov State University). *Sov. Phys. - Tech. Phys. (Engl. Transl.);* **22**: No. 7, 841-844(Jul 1977).

A method for diagnostics of a beam-plasma system is proposed. The method is based on the voltage-current characteristics of the ion current drawn by a two-electrode probe. Measurements of the radial and axial variations in the potential are reported for the plasma produced by an extended electron beam which is focused in a homogeneous magnetic field and a periodic magnetic field. The average longitudinal ion velocity is estimated

PLASMA KINETICS - GENERAL

38593 (INDC(NDS)—88/GB) First meeting of the atomic and molecular data centre network, Vienna, 9-13 May 1977. Summary report. Lorenz, A.; Seamon, R.E. (ed.). (International Atomic Energy Agency, Vienna (Austria). International Nuclear Data Committee). Aug 1977. 120p. Dep. NTIS (US Sales Only), PC A02/MF A01.

The general objective of the effort started at this meeting is the formation of an internationally coordinated network of centres and groups for the systematic world-wide compilation, evaluation, exchange and dissemination of bibliographic and numerical A+M data required by the fusion community. The specific accomplishments of this meeting were the establishment of agreements for the cooperation between existing A+M data centres and groups and the IAEA Nuclear Data Section/A+M Data Unit with regard to the Quarterly Bulletin on Atomic and Molecular Data for Fusion, the Bibliographic Index to Atomic Collision Data, and the exchange of evaluated atomic collision data.

38594 (INDC(SEC)—63/GA) Minutes of the second meeting of the Joint IFRC/INDC sub-committee on atomic and molecular data for fusion, Vienna, 14 May 1977. Lorenz, A.; Seamon, R.E. (International Atomic Energy Agency, Vienna (Austria). International Nuclear Data Committee). Aug 1977. 6p. Dep. NTIS (US Sales Only), PC A02/MF A01.

In this paper the minutes of the second meeting of the Joint IFRC/INDC Subcommittee (International Fusion Research Committee - International Nuclear Data Committee) on Atomic and Molecular Data for Fusion are given.

38595 Investigation of the properties of a high energy, magnetically confined, nonneutral electron plasma. Armstrong, C.M. College Park, MD; Univ. of Maryland (1976). 238p. University Microfilms Order No. 77-21,343.

Thesis (Ph. D.).

The properties of both stable and unstable magnetically confined, nonneutral hot electron plasmas are investigated. Specifically, this work is concerned with the equilibrium and stability of an electron cloud produced in a time varying magnetic mirror field by injection of a 100 keV electron beam. To optimize the mean energy and density of the electron cloud and to study the effect of the method of electron injection on the stability of the cloud, three beam handling systems are employed. They are axial injection of an overdense beam, helical injection and injection of an annular electron beam through a cusped magnetic field. Injection through a cusped field is found to be a method consistent with the production of stable nonneutral electron plasmas, which evolve adiabatically. These plasmas have mean kinetic energies of 2.6 MeV at peak compression with energy spreads of 0.5 MeV at half maximum, consisting of approximately 4×10^{11} electrons.

PLASMA KINETICS - EXPERIMENTAL

38596 (PPPL—1432) Radially resolved measurements of "q" on the ATC tokamak. Goldston, R.J. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Apr 1978. Contract EY-76-C-02-3073. 37p. Dep. NTIS, PC A03/MF A01.

This paper describes a new technique for directly measuring the safety factor, or q, profile in a tokamak. A tightly collimated neutral beam capable of injecting approximately 100 mA of 30 keV deuterium atoms was mounted on the ATC tokamak. By proper tangential aiming of the beam a strong concentration of circulating fast ions was created at a chosen plasma minor radius. By examining the orbits of these ions with a multi-sight-line charge exchange detector, it was possible to measure the shifts of the orbits off of magnetic surfaces, and thereby to make local measurements of q. This experiment showed that when q on axis reached unity, strong internal turbulence began, and further lowering of q at the outer edge of the plasma did not lower q(0). A second result was that the measured q(0) was approximately 1.8 times larger than the q(0) deduced from the T/sub e/(r) profile, assuming z/sub eff/ to be independent of minor radius. This suggests a significant peaking of z/sub eff/ on axis in ATC.

38597 (UCRL-Trans—11344) Emissive properties of electrodes of surface-plasma sources and the efficiency of H^- ion generation. Dudnikov, V.G.; Obrazovskii, E.G.; Fiksel, G.I. (AN SSSR, Novosibirsk. Inst. Yadernoj Fiziki). Mar 1978. Translation of IYaF—77-50, Academy of Sciences of the USSR, Novosibirsk, 1977. 14p. Dep. NTIS, PC A02/MF A01.

Portions of document are illegible.

The ratio of the discharge current density at the cathode, j/sub d/, to the current density of positive ions, j/sub +/, was determined from the yield of positive ions through narrow slits in the cathodes of a Penning cell. As the discharge voltage U/sub d/ in the surface plasma source (SPS) decreased as a result of the supply of cesium, j/sub d//j/sub +/ increased from 1.1 to 1.2 at U/sub d/ = 400 to 600 V to j/sub d//j/sub +/ approximately equal to 6-8 at U/sub d/ = 100 V, and the secondary emission factor of hydrogen ions increased from K^- = j/sub -//j/sub +/ approximately equal to 0.01 to K^- approximately equal to 0.6-0.8. With such emissive

properties of the electrodes, the energy cost of formation of H^- ions in an SPS can be decreased to P/sub -/ approximately equal to 250 eV/ion.

38598 (UCRL-Trans—11341) **Physical principles of the surface-plasma method of producing beams of negative ions.** Bel'chenko, Yu.I.; Dimov, G.I.; Dudnikov, V.G. (AN SSSR, Novosibirsk. Inst. Yadernoj Fiziki). Feb 1978. Translation of IYaF—77-56, Academy of Sciences of the USSR, Novosibirsk, 1977. 59p. Dep. NTIS, PC A04/MF A01.

A study is made of the processes used to produce intensive beams of negative ions from surface-plasma sources (SPS). The concepts now being formulated concerning the formation of negative ions upon interaction of bombarding particles with the surface of a solid are analyzed. The peculiarities of the realization of optimal conditions for the production of beams of negative ions in SPS of various designs are discussed.

PLASMA KINETICS - THEORETICAL

38599 (ANL/FPP—77-4, pp 90-92) **Applied plasma physics.** 1977.

In Fusion Power Program. Quarterly progress report, July—September 1977.

An evaluation of the Spitzer function of a multispecies plasma is briefly discussed. A discussion of the Bethe cross sections for ionization of Na and Fe^{15+} by fast electrons is also given. (MOW)

38600 (UCRL—52436) **Guiding center simulations of strong ion beams with applications to the Counterstreaming Ion Torus.** Tull, C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Mar 1978. Contract W-7405-ENG-48. 215p. Dep. NTIS, PC A10/MF A01.

Thesis.

In the proposed Counterstreaming Ion Torus (CIT) steady state rather than pulsed operation may be possible if all of the plasma power density is provided by neutral beam injection. After the neutral beams have penetrated the magnetic field, strong ion beam currents are produced. A major concern with the relatively strong counterstreaming ion currents is the effect of the beam self-magnetic fields on the macroscopic equilibrium of the system. Pinching and self focusing of the individual beams may occur, or the repulsive interaction of the two oppositely directed beam currents may destroy the equilibrium entirely. We investigate this macroscopic behavior of the ion beams with a guiding center plasma particle simulation model and we describe a model we have developed to simulate steady state behavior in an ideal CIT configuration.

38601 **Effective Ohm's law for magnetized plasmas with anisotropic inhomogeneities.** Shamma, S.E.; Martinez-Sanchez, M.; Louis, J.F. (Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Fluids;* **21**: No. 5, 773-782(May 1978).

Reduction formulae for the effective, or macroscopic, Ohm's law parameters are derived for inhomogeneous plasmas with anisotropic conductivity fluctuations having two general types of geometry: (a) elongated or shortened in the direction of the magnetic field and (b) two-dimensional, with the direction of constant properties lying in the plane perpendicular to the magnetic field. In each case, two approaches are used: (a) a small perturbation method and (b) an approximate method where each region in the plasma is considered separately, and consistency conditions are used to relate the results corresponding to each separate region to the effective properties of the whole plasma. Both methods are found to agree well when the fluctuations are weak, but differences appear at high fluctuation levels and, for nonuniformities very elongated along B, when the Hall parameter β is high. Comparison with available exact solutions valid at high β and strong fluctuation levels indicates that the self-consistency method gives accurate results even in these cases. The results of these analyses are used to evaluate the performance reduction in magnetohydrodynamic channels with plasma nonuniformities of several geometries, including axial streamers, perfectly isotropic fluctuations, and fluctuations elongated along B; the power density is reduced most strongly when β and the rms of the fluctuations are high, and also when the inhomogeneities are stretched along the magnetic field.

38602 **Role of clumps in drift-wave turbulence.** Dupree, T.H. (Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Fluids;* **21**: No. 5, 783-792(May 1978).

A new model of collisionless drift-wave turbulence for k/sub perpendicular/a/sub i/very-much-less-than1 is explored that can explain the experimentally observed spectra in a simple way. The model includes clumps on an equal footing with drift waves. The calculation is approximate but does confirm the feasibility of the model and demonstrates that clumps are likely to be an important feature of drift-wave-related turbulence.

38603 **Neoclassical transportation in the ELMO bumpy torus.** Jaeger, E.F.; Spong, D.A.; Hedrick, C.L. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev. Lett.;* **40**: No. 13, 866-869(27 Mar 1978).

In the ELMO bumpy torus, neoclassical transport coefficients depend critically on the ambipolar electric field. These coefficients, calculated for arbitrary radial electric fields, are applied in a one-dimensional radial-transport calculation which, for the first time, treats the electric field self-consistently. This purely classical model predicts many features of experimentally operation including a steady-state solutions with radially inward-pointing ambipolar fields.

38604 **Accessibility of equilibria in an electron beam plasma system.** Cavalli, A. Hanover, NH; Dartmouth College (1977). 124p. University Microfilms Order No. 77-22,588.

Thesis (Ph. D.).

The long time evolution of an electron beam plasma system has been modeled with a set of non-linear rate equations. These equations contain the dominant physical processes which govern the long time behavior of the particle density, the electron distribution, and the wave energy stored in the beam driven electrostatic fluctuations. Solutions to these equations, when interpreted from the point of view embodied in phase plane analysis, show characteristically different multiple equilibria. These equilibria are accessible to the plasma at various stages of its evolution and determine its behavior at a given operating point. The behavior implied by these results is shown to be in agreement with experimental observations.

38605 **Evolution of a test particle distribution function in a partially ionized plasma.** Hsu, T.S.T. New Haven; Yale Univ. (1977). 79p. University Microfilms Order No. 77-27,813.

Thesis (Ph. D.).

This thesis outlines an experiment conceived to observe the evolution of the energy distribution of a selected group of electrons (the test particles) as they interact with a background plasma through electron—electron (e—e), electron—ion (e—i), and elastic electron-neutral (e—n) collisions. The plasma used was the afterglow of a pulsed microwave discharge ($10^{10} <$ n/sub e/ $< 10^{12}$ cm^{-3}, T/sub e/ approximately 0.1 eV). The test particles were injected into the plasma as a feeble quasi-monoenergetic beam. For the test particles, the e-n mean-free-path lambda was much smaller than the length of the plasma L, while the e-e mean-free path was much greater.

38606 **Study of Stark broadening of high-Z hydrogenic ion lines in dense hot plasmas.** Tighe, R.J. Gainesville, FL; Univ. of Florida (1977). 257p. University Microfilms Order No. 77-29,288.

Thesis (Ph. D.).

Stark broadened x-ray line profiles from highly ionized hydrogenic ions, radiating while immersed in a hot dense plasma, are studied. The broadening effects produced by the ions present in the plasma are treated through the use of static electric microfield distribution functions. The microfiel distribution functions employed have the following properties: (1) the radiating hydrogenic ion may have any net charge; (2) the perturbing ions and electrons in the plasma may have different kinetic temperatures; (3) two species of ions, of charge z_1 and z_2, may be present in any given ratio. Electron broadening effects are treated by the Second-Order Relaxation Theory as developed by O'Brien and Hooper, Effects upon the electron perturbers due to the fact that the radiator is highly charged are included through the use of Coulomb wave functions for the perturbing electrons. The present work makes extensions needed for the calculation of line profiles from higher Lyman series members. A cutoff procedure is employed to simulate the effects due to correlations among the electron perturbers. Results are presented in graphical and tabular form for both the electric microfield distribution functions and for the broadened line profiles.

38607 **Development of a one dimensional fluid transport model and the analysis of thermal stability in large tokamaks.** Houlberg, W.A. Madison, WI; Univ. of Wisconsin (1977). 196p. University Microfilms Order No. 77-17,834.

Thesis (Ph. D.).

The research reported here is centered around the fluid analysis of the one dimensional particle and energy balance equations for large tokamak plasmas. It is divided into two parts: the development of improved numerical techniques for better simulation of the fluid equations and the use of the one dimennal fluid model for analysis of thermal stability in large tokamaks.

PLASMA PRODUCTION

38608 **Classification of Be i-like and B i-like iron and vanadium spectra from laser-produced plasmas.** Bromage, G.E.; Cowan, R.D.; Fawcett, B.C.; Ridgeley, A. (Appleton Laboratory, Astrophysics Research Division, Science Research Council, Culham Laboratory, Abingdon, United Kingdom). *J. Opt. Soc. Am.;* **68**: No. 1, 48-51(Jan 1978).

Be i-like spectra of V xx and Fe xxiii and B i-like spectra of Fe xxii are classified as a result of spectroscopic observations of the plasmas formed by focusing the output of a neodymium glass laser onto plane solid targets. Wavelength measurements published by the Lebedev Institute, Moscow, were also used, for the iron spectra. The analysis was undertaken with the help of theoretical calculations of atomic energy levels and oscillator strengths.

38609 Computer simulation for the creation of a transient high density plasma by convergent neutral beams. Eggens, C.J. Davis, CA; Univ. of California (1977). 61p. University Microfilms Order No. 77-20,909.

Thesis (Ph. D.).

A new computer simulation model is developed to calculate detailed trajectories and interactions of neutral particles. This model will be used to verify approximate calculations of a new idea for plasma creation utilizing pulsed neutral beams. In this new application, a spherical array of inwardly directed pulsed neutral beam sources would be velocity modulated so to create bunching of the neutral beams timed to coincide with the geometrical convergence of the beams at the center of the sphere. In this way, it is predicted that upon convergence the beam density will be multiplied by many orders of magnitude. At the target point, either collisional self ionization or ionization by impact on a target plasma would result in the conversion of the neutral particle cloud to a transient high density plasma. This technique may have applicability in high density plasma research for fusion power.

PLASMA INSTABILITIES

38610 (CLM-R—150) Stability close to the magnetic axis in a toroid for vanishing pressure gradient. Robinson, D.C. (UKAEA Research Group, Abingdon. Culham Lab.). Jul 1977. 8p. Dep. NTIS (US Sales Only), PC A02/MF A01.

Also available from H.M. Stationery Office, price Pound0.50.

Localised helical instabilities, which arise due to vanishing pressure gradients close to the magnetic axis in cylindrical and toroidal geometry, have been investigated. The criteria for hydromagnetic stability is shown, and conditions assuring stability are discussed.

38611 (IAE—2644) Bounce effects in instability theory of trapped alpha particles in a tokamak reactor. Kadze, T.D.; Mikhailovskii, A.B. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1976. 16p. (In Russian). Dep. NTIS (US Sales Only), PC A02/MF A01.

The role of resonances in the cyclotron build-up of fast magnetoacoustic waves by trapped alpha-particles is theoretically investigated in a tokamak-reactor. The resonances are shown to lead to an additional increase in the increment of growth of fast magnetoacoustic waves by the magnitude of the order of 0.5 (epsilon ωsub(BS)/ωsub(R)sup(1/3), where ωsub(BS) is the cyclotron frequency of alpha-particles mean on the magnetic surface, ωsub(R) is their resonance frequency, epsilon is the ratio of the minor tokamak radius to the major one.

38612 (PPPL—1420) Resistive drift and Alfven instabilities in sheared magnetic fields. Hsu, J.; Chen, L.; Kaw, P. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Apr 1978. Contract EY-76-C-02-3073. 13p. Dep. NTIS, PC A02/MF A01.

It is shown that, due to finite-β effects, there exist unstable resistive drift and Alfven eigenmodes in a slab plasma with finite magnetic shear. The corresponding growth rates of both instabilities scale with the electron-ion collision frequency ν/sub ei/ as ν/sub ei//sup $^1/_2$/.

38613 (TID—28384) Introduction to tearing modes. Satya, Y.; Schmidt, G. (Stevens Inst. of Tech., Hoboken, N.J. (USA)). Feb 1978. Contract EY-76-S-02-3004. 22p. Dep. NTIS, PC A03/MF A01.

A simplified, uniform treatment of the linear theory of tearing modes is given. Tearing modes arise in a plasma situated in a sheared magnetic field and are driven by the magnetic energy stored in the system. Equations are given for the energy source, uniform conductivity, and the collisionless tearing mode. (MOW)

38614 Nonlinear behavior of linearly unstable magnetohydrodynamic modes. Pao, Y. (Courant Institute of Mathematical Sciences, New York University, New York, New York 10012). *Phys. Fluids;* **21**: No. 5, 765-772(May 1978).

It can be shown that for linearly unstable magnetohydrodynamic modes near the threshold of linear instability, the mode amplitude A(t) evolves according to partial^{2}A/Λt^2 $=\lambda^2 A+\alpha A^3$ which can lead to nonlinear stabilization, explosive instability, or eventual decay, depending on the sign of α. This is demonstrated explicitly for the m=1 kink modes in a sharp boundary plasma pinch.

38615 Plasma convection instability in an inhomogeneous magnetic field. Ottinger, P.; Guillory, J.; Lashinsky, H. (Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). *Phys. Fluids;* **21**: No. 5, 798-807(May 1978).

A convection instability characteristic of plasmas in an inhomogeneous azimuthal magnetic field is treated in the linear stage and in nonlinear saturation. The analysis is done in such a way that collisional and collisionless limits can be taken, and these limits are displayed along with the more general intermediate result. The instability, known previously in the literature in its collision-dominated form, is shown to be a "flute" instability with collisional modifications to the growth rate. The nonlinear saturation is analyzed by examining a finite amplitude restoring-force term in the differential equation that describes the instability. This term is due to the fact that the instability convects plasma into striations of the plasma column surface, modifying the density gradient driving force. The effects of finite ion gyroradius are displayed, and applications of this study to convection cells in a thermal plasma and to exploding wire plasmas are discussed.

38616 Wall stabilization of axisymmetric modes in noncircular tokamak plasmas. Chu, M.; Miller, R.L. (General Atomic Company, San Diego, California 92138). *Phys. Fluids;* **21**: No. 5, 817-826(May 1978).

The axisymmetric stability of tokamak equilibria with arbitrary cross section is studied numerically using the energy principle. The contribution to δW from the plasma region is minimized analytically with respect to displacements in the toroidal and poloidal directions. the formulation of Luest and Martensen is used for the vacuum contribution. Bessel-Fourier and other sets of trial functions are then employed to cast the minimization of δW into a matrix eigenvalue problem. A computer code named axisym evaluates these matrix elements and solves for the eigenvalues. The code is fully toroidal and compressible mode trial functions are included. Wall stabilization is studied by placing a conducting wall around the vacuum region.

38617 Stability of interchange modes in a hot electron plasma. Dominguez, R.R.; Berk, H.L. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *Phys. Fluids;* **21**: No. 5, 827-834(May 1978).

A self-consistent electromagnetic theory is presented, for arbitrary β, of the flute-interchange mode of a hot-electron plasma where the hot-electron guiding-center drift frequency may be comparable to or larger than the ion-cyclotron frequency. In the presence of bad curvature, an interchange instability exists at small and large precessional frequency, and this instability is stabilized by cold electrons. Electromagnetic theory introduces finite-β corrections that only modify the results of a simple electrostatic theory that includes only the external drifts.

38618 Stabilization of drift-cyclotron loss-cone mode by low-frequency density fluctuations. Hasegawa, A. (Bell Laboratories, Murray Hill, New Jersey 07974). *Phys. Rev. Lett.;* **40**: No. 14, 938-941(3 Apr 1978).

Low-frequency (ω very-much-less-than ω/sub ci/) density fluctuations (which may be produced by the drift-wave instability of the cold-ion species) can stabilize the drift-cyclotron loss-cone (DCLC) mode by scattering electrons and therby providing anomalous high-frequency resistivity to the DCLC mode.

38619 Transverse self-focusing and filamentation of a laser beam in a magnetoplasma. Sharma, A.K. (Physics Department, Agra College, Agra, India). *J. Appl. Phys.;* **49**: No. 4, 2396-2400(Apr 1978).

In this paper we have studied the problem of self-focusing of a Gaussian laser beam in a collisionless magnetoplasma when the direction of wave propagation is at right angles to the magnetic field. The nonlinearity arises through the ponderomotive force and subsequent redistribution of plasma along the magnetic field. It is seen that as the magnetic field increases the extent of self-focusing increases. The isointensity surfaces of a three-dimensional beam are elliptical. In the case of a plane-uniform laser beam it is seen that it is unstable for small-scale fluctuations, and the growth rate of instability increases very rapidly with magnetic field.

38620 Saturation of parametric instabilities by nonlinear four-wave coupling. Yuen, S.Y. (Francis Bitter National Magnet Laboratory, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Rev. Lett.;* **40**: No. 13, 869-872(27 Mar 1978).

Nonlinear coupling of four Langmuir waves is studied as a new saturation mechanism for parametric instabilities in underdense plasma with approximately equal electron and ion temperatures. When treated in conjunction with the usual ion nonlinear Landau damping, these processes produce a saturated Langmuir-wave spectrum with a single peak ans a saturated wave energy linearly proportional to the pump intensity. These results are in good agreement with laboratory experiments.

38621 Simulation model for studying low-frequency microinstabilities. Lee, W.W.; Okuda, H. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08540). *J. Comput. Phys.;* **26**: No. 2, 139-180(Feb 1978).

A 21/2-dimensional, electrostatic particle code in a slab geometry has been developed to study low-frequency oscillations such as drift wave and trapped particle instabilities in a nonuniform bounded plasma. A drift approximation for the electron transverse motion is made which eliminates the high-freqeuncy oscillations at the electron gyrofrequency and its multiples. It is, therefore, possible to study the nonlinear effects such as the anomalous transport of plasmas within a reasonable computing time using a real mass ratio. Several examples are given to check the validity and usefulness of the model, including those using full electron dynamics.

38622 Suppression of plasma instabilities by the feedback method. Arsenin, V.V.; Chuyanov, V.A. *Sov. Phys. - Usp. (Engl. Transl.);* **20**: No. 9, 736-762(Sep 1977).

A new method of suppressing plasma instabilities with the aid of automatic control systems has been recently developed. The feasibility of using this method to stabilize a continuous medium is brought about by the fact that not all of the tremendous number of degrees of freedom of the medium are actually excited, but only several of the modes. The method is most suitable in practice for the suppression of large-scale oscillations. Two stabilization methods have been observed. An external control system can be used to alter the phase velocities of the waves in the plasma, thus upsetting their resonant interaction with the particles and with one another. This suppresses strong instabilities with large growth rates, particularly hydrodynamic ones (flute, helical, etc.). To eliminate instabilities of the dissipative type with small growth rates it suffices to use an external system to introduce additional damping of the plasma oscillations. The possibility of turning individual modes on or off makes feedback an outstanding tool for the study of nonlinear properties of oscillations, anoalous transport phenomena, and others. The first experiments in this direction have already been performed.

38623 Solitons in a parametrically unstable plasma. Kuznetsov, E.A. (Institute of Automation and Electrometry, Siberian Branch of the Academy of Sciences of the USSR, Novosibirsk). *Sov. Phys. - Dokl. (Engl. Transl.);* **22**: No. 9, 507-508(Sep 1977).

It is shown that when analyzing Langmuir waves a change in the boundary conditions can lead to drastically different mathematical results.

38624 Evolution of parametrically excited instabilities in a magneto plasma column. Yip, T.Q. Brooklyn; Polytechnic Inst. of New York (1977). 110p. University Microfilms Order No. 77-21,100.

Thesis (Ph. D.).

Experiments on parametric decay instabilities have been conducted in a hollow cathode arc generated plasma in a static magnetic field. The device consists of an argon arc discharge between a hollow tantalum cathode and a baffle anode. The plasma passes through a hole on this anode into a floating drift region with a uniform magnetic field. The plasma can be operated in the range of 10^{11} to 10^{13} cm^{-3} in density, and of 2 to 6 eV in electron temperature. The ppercentage of ionization is controlled by feeding neutral gas into the experimental drift region. A microwave horn is mounted at the end of the plasma beam, and the pump signal, provided by an ultra-stable microwave source, and amplified 50 dB by a sophisticated generator/amplifier, can be operated up to 1 KW CW. With the plasma parameters at their proper values, two modes are simultaneously excited when the pump signal, at 9.23 GHz, exceeds a threshold power level of 65 W. These parametrically excited waves correspond to the 3rd harmonic of electron cyclotron and the electrostatic ion cyclotron modes, at requencies of about 9.2 GHz and 260 KHz respectively. The evolution process of the electrostatic ion cyclotron wave is studied by switching the microwave pump power from a fixed level above the threshold to one below. A phenomenological model is used to describe the observed phenomena, and to determine the decay rate at various power levels, the linear and non-linear damping terms.

38625 Study of drift, Alfven, and tearing modes in a nonuniform plasma with sheared magnetic fields. Hsu, J.Y. Princeton, NJ; Princeton Univ. (1977). 149p. University Microfilms Order No. 77-28,105.

Thesis (Ph. D.).

Drift instabilities in a uniformly sheared magnetic field are discussed. Close to a mode-rational surface dissipative processes play a dominant role, so that matching procedure for solving the eigenvalue problem in a collisional plasma is developed. The results of this analysis are shown to be in good agreement with those obtained from perturbation theory. The shear stabilization together with finite-beta effects on collisional drift waves are new. The collisionless case has also been treated by a perturbation method, and the results are compared with those obtained by previous workers. The second chapter discusses a new instability which can produce a local breakup of the rational magnetic surface. This instability is associated with the Alfven branch of the low-frequency dispersion relation. The third chapter investigates the influence of a given saturated microturbulence of electrostatic drift waves on the stability of long-scale-length magnetohydrodynamic modes like the tearing mode. The dominant effect from coupling to this turbulence yields an ion viscosity-like term in the inner-layer equations. With the constant-PSI approximation, it is concluded that even a small-amplitude background turbulence is sufficient to strongly modify the growth rate.

38626 Cyclotron instabilities in a hydrogen plasma. Horng, J.T. *Chin. J. Phys. (Taiwan);* **14**: No. 4, 85-89(Win 1976).

Cyclotron instabilities in a thermally anisotropic hydrogen plasma due to resonant particles laying near the peak of their distribution functions are obtained in two cases. In the first case both protons and electrons have resonant particles near the peak of their distribution functions. The instabilities are found to be driven by both proton and electron thermal anisotropy of the resonant particles. In the second case only electron component has resonant particles near the peak of its distribution function. The instabilities are found to be driven by thermal anisotropy of the resonant electrons. Possible application to the interplanetary medium are briefly discussed.

PLASMA WAVE PHENOMENA

38627 (FUPH-R—139) **Magnetoacoustic oscillations in a current carrying plasma column.** Sy, W.N. (Flinders Univ. of South Australia, Bedford Park. School of Physical Sciences). Mar 1977. 27p. Dep. NTIS (US Sales Only), PC A03/MF A01.

The forced radial magneto-acoustic oscillations in a partially-ionized, low-β plasma column with non-uniform densities, temperature and axial current are investigated theoretically. By using a method of successive approximations to include resistive and viscous dissipations, the description of these oscillations has been reduced to the solution of a second order differential equation in the axial magnetic field disturbance bsub(z)(r) . A detailed numerical solution is presented for a case where the axial current is uniform and the dissipation is resistive. It is shown that the steady axial current enhances the magnetic field amplitudes at magneto-acoustic resonance.

38628 (FUPH-R—140) **Spectrum of axisymmetric torsional Alfven waves.** Sy, W.N. (Flinders Univ. of South Australia, Bedford Park. School of Physical Sciences). Mar 1977. 10p. Dep. NTIS (US Sales Only), PC A02/MF A01.

The spectrum of axisymmetric torsional Alfven waves propagating in a cylindrical, non-uniform, resistive plasma waveguide has been analysed by a method of singular perturbations. A simple condition has been derived which predicts whether the spectrum is continuous or discrete under given physical conditions. Application of this result to resolve an apparent discrepancy in experimental observations is briefly discussed.

38629 (FUPH-R—141) **Magnetoacoustic oscillations of a plasma containing two species of ions.** Jessup, B.L.; McCarthy, A.L. (Flinders Univ. of South Australia, Bedford Park. School of Physical Sciences). May 1977. 26p. Dep. NTIS (US Sales Only), PC A03/MF A01.

Numerical calculations of magnetoacoustic resonant phenomena in a plasma containing two species of ions have been made for a cylindrical plasma with a model which includes the effects of collisional damping and radial non-uniformities in temperature and number density. At sufficiently high temperatures two frequencies are predicted at which magnetoacoustic resonances for the first radial mode will occur. These are expected from considerations of the effects of the ion-ion hybrid resonance.

38630 (FUPH-R—143) **Nonlinear behaviour of axisymmetric hydromagnetic waves in a partially ionized plasma.** Sawley, M. (Flinders Univ. of South Australia, Bedford Park. School of Physical Sciences). Oct 1977. 23p. Dep. NTIS (US Sales Only), PC A03/MF A01.

Finite amplitude effects in the propagation of axisymmetric hydromagnetic waves in a cylindrical, magnetized plasma are considered. The influence of the Hall term and the presence of neutral atoms on the resulting second order fields is examined. The combined effect of these two factors is to produce a substantial secord order azimuthal field, in addition to the axial field predicted by earlier work which neglected these factors. In some circumstances this azimuthal field is much larger than the axial field.

38631 (FUPH-R—144) **Observation of nonlinear effects in the propagation of m = 0 torsional hydromagnetic waves.** Brennan, M.H.; Cheetham, A.D.; Jones, I.R.; Sawley, M.L. (Flinders Univ. of South Australia, Bedford Park. School of Physical Sciences). Oct 1977. 21p. Dep. NTIS (US Sales Only), PC A03/MF A01.

The linear behaviour of hydromagnetic waves in a cylindrical magnetized plasma has been extensively studied both theoretically and experimentally. The behaviour of strongly nonlinear hydromagnetic waves has also received considerable attention. The transition from the linear to a weakly nonlinear regime is, however, not so well documented. The quantitative experimental examination of hydromagnetic wave propagation in this intermediate regime forms the subject of this paper.

38632 (Juel—1424) Incoherent scattering of light by a moderately hot magnetized plasma. Carolan, P.G. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Plasmaphysik; Association Euratom-KFA, Juelich (Germany, F.R.)). Jun 1977. 11p. Dep. NTIS (US Sales Only), PC A02/MF A01.

Present theory on light scattering predicts that, for a well aligned experiment, peaks separated by the electron gyro frequency will be observed in the spectrum of light scattered by a magnetized plasma. The usual approximation of setting the scattered wave vector equal in magnitude to the incident one is generally made to calculate the shift in frequency in the scattered light. Such an approximation can lead to errors in this shift. The depth of modulation in the scattered spectrum will thus be less than that predicted hitherto. In the present more accurate analysis a useful parameter γ was found. When γ approximately > 3 the modulation will virtually disappear even for a perfectly aligned experiment, but for $\gamma << 1$ the smearing effect will be insignificant. Thus for the observation of 'magnetic modulation' long wavelength lasers or forward scattering is favoured in high temperature plasmas.

38633 Class of multidimensional nonlinear Langmuir waves. Wang, P.K.C. (School of Engineering and Applied Science, University of California, Los Angeles, California 90024). *J. Math. Phys. (N.Y.);* **19**: No. 6, 1286-1292(Jun 1978).

Nonlinear Langmuir waves in a plasma governed by the dimensionless equations ipartialE/partialt=-del^{2}E+nE, partial^{2}n/partialt^2 =del^2[n+g(vertical-barEvertical-bar^2)] are studied, where E is the complex amplitude of the high-frequency electric field, n is the low frequency perturbation in the ion density from its constant equilibrium value, and g is a given function of vertical-barEvertical-bar^2. General conditions for the existence or nonexistence of a class of multidimensional solitary-wave and nonlinear periodic travelling-wave solutions in the form E(t,x) =h(kxx-vt) and n(t,x) =s(kxx -vt) are established. The results are applied to the special cases: (i) g(vertical-barEvertical-bar^2) =vertical-barEvertical-bar^2 corresponding to the usual pondermotive force, and (ii) g(vertical-barEvertical-bar^2) =K[1-exp(-vertical-barEvertical-bar^2)], K is a positive constant, representing ion density saturation.

38634 Three- and four-wave interactions in plasmas. Boyd, T.J.M.; Turner, J.G. (University of Wales, U.C.N.W., Bangor, Wales). *J. Math. Phys. (N.Y.);* **19**: No. 6, 1403-1413(Jun 1978).

The nonlinear interaction of three and four waves in a warm magnetized plasma is studied using the Lagrangian formalism. General expressions for the coupling coefficients are obtained in each case. Coupled-mode equations describing four-wave interactions have been derived and solved. The extension of the theory to the interaction of random phase waves and weak inhomogeneity is also discussed.

38635 Intensity dependence of inverse bremsstrahlung absorption in an inhomogeneous standing wave. Faehl, R.J.; Roderick, N.F. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Phys. Fluids;* **21**: No. 5, 793-797(May 1978).

The intensity dependence of inverse bremsstrahlung due to the oscillating velocity of electrons in a laser field can severely degrade collisional absorption efficiency. Previous work has concentrated on the classical and quantum expressions for the absorption rate. Total absorption requires evaluation of such expressions in the inhomogeneous field structure within the plasma, however. Both analytic and numerical calculations to determine the magnitude of the fractional reduction in absorption have been undertaken for the realistic case of an inhomogeneous standing wave. A simple physical model is derived and extrapolated to Airy-like field distributions. Numerical calculations employing fluid simulations with a heuristic intensity dependence were found to be in excellent agreement with an analytic model.

38636 Parametric excitation of ion-cyclotron waves by a pump magnetic field in a high-temperature plasma. Cramer, N.F. (School of Physics, University of Sydney, Sydney, New South Wales, 2006, Australia). *Phys. Fluids;* **21**: No. 5, 835-840(May 1978).

The growth rate of ion-cyclotron waves, parametrically excited by a pump magnetic field oscillating in time in a hot plasma, is calculated. The process occurs through the excitation of a slow ion-cyclotron wave and a fast wave propagating in opposite directions along the magnetic field, as has been found previously for the case of a cold plasma. The growth rate of the waves is found to vanish at a critical temperature, that temperature being higher for a lower value of the ratio of the pump frequency to the ion-cyclotron frequency. Below the critical temperature the growth rate is always less than the cold plasma growth rate.

38637 Enhancement of drift waves by localized lower hybrid waves. Wong, K.L.; Bellan, P.M. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08540). *Phys. Fluids;* **21**: No. 5, 841-845(May 1978).

The enhancement of low frequency oscillations by lower hybrid waves at electric fields lower than the thresholds of other parametric decay processes is presented. The frequencies and wavelengths of these oscillations agree with the collisional drift wave dispersion relation. The enhancement is localized deep inside the plasma density gradient. The excited drift waves change the density profile and the lower hybrid wave trajectory.

38638 Two-dimensional depletion of a lower hybrid pump by quasi-mode excitations. Sen, A.; Karney, C.F.F.; Bers, A. (Plasma Fusion Center and Research Laboratory of Electronics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Fluids;* **21**: No. 5, 861-863(May 1978).

The depletion of a finite extent lower hybrid pump wave due to the parametric excitation of quasi-modes is calculated for parameters relevant to tokamak plasmas.

38639 Coherent counter-steaming electrostatic wave Raman interaction system utilizing opposing electron beams for the production of coherent microwaves in plasmas. Leiby, C.C. Jr.; Prasad, B. US Patent 4,059,813. 22 Nov 1977. Filed date 12 Jan 1977. 8p.

The generation of controlled, electromagnetic, coherent, microwave radiation from a warm, uniform plasma at approximately twice the electron plasma frequency by means of two oppositely directed streams of high energy electrons and the coupling of the resulting coherent, electromagnetic radiation from a cavity resonator into external circuitry, wherein the two opposing streams of high energy electrons directed into the warm, uniform plasma result in a conversion of electron beam and plasma energies into transverse electromagnetic radiation from 10 to 100 times that which is possible with a single electron beam-plasma system. 7 claims, 4 figures.

38640 Production of a proton beam in the beam-plasma interaction. Zemlyanskii, N.M.; Zeidlits, V.P.; Berezin, A.K.; Ponomarev, A.G. *Sov. Tech. Phys. Lett. (Engl. Transl.);* **3**: No. 10, 401-402(Oct 1977).

Experiments are reported on proton acceleration in the interaction of a hollow electron beam with a plasma. The protons are accelerated by low-frequency waves.

38641 Excitation of Alfven waves by fast ions in a finite-β plasma. Mikhailovskii, A.B.; Pokhotelov, O.A. (O. Yu. Shmidt Institute of Geophysics). *Sov. Phys. - Tech. Phys. (Engl. Transl.);* **22**: No. 7, 779-782(Jul 1977).

The excitation of Alfven waves by fast ions in a plasma in a straight magnetic field is analyzed. The most important effect is the resonant wave interaction with the fast ions, which is manifested only when the finite ion Larmor radius is taken into account. The growth rate for the Alfven waves is derived.

38642 Absorption of electromagnetic waves in a plasma in the presence of a quantizing magnetic field. Kolesov, V.V. (Urals State University). *Sov. Phys. - JETP (Engl. Transl.);* **45**: No. 4, 847-849(Apr 1977).

An expression for the effective electron-ion collision rate in the region of weak spatial dispersion is found for an electron-ion plasma located in a strong magnetic field. It is shown that the effective collision rate should decrease in a strong quantizing magnetic field.

38643 Reflection and absorption of ion-acoustic waves in a plasma density gradient. Ishihara, O. Knoxville, TN; Univ. of Tennessee (1977). 60p. University Microfilms Order No. 77-27,667. Thesis (Ph. D.).

Plasma is characterized by electrical quasineutrality and the collective behavior. There exists a longitudinal low-frequency wave called an ion-acoustic wave in a plasma. One problem in the experimental study of ion-acoustic waves has been that sometimes they are observed to be reflected from discharge tube walls, and sometimes to be absorbed. Theoretical computation reveals that a velocity gradient produced by a density gradient plays a significant role in the reflection. The velocity gradient produces the subsonic-supersonic transition and long wavelength waves are reflected before reaching the transition while short wavelength waves penetrate over the transition and are absorbed in the supersonic flow plasma.

38644 Spectral distribution of wave power in wide-band beam plasma turbulence. Greenly, J.B. Hanover, NH; Dartmouth College (1977). 160p. University Microfilms Order No. 77-22,589. Thesis (Ph. D.).

The strong turbulent limit of the beam plasma interaction is the object of this experimental and theoretical investigation. Experiments were performed in a strongly magnetized plasma of density 10^9—10^{10}/cm, with a beam of up to two kilovolt energy and one hundred watt power. The strongest interaction is observed to be a temporal steady state in which the beam is totally scattered, within the one meter plasma length, into a non-Maxwellian tail on the electron velocity distribution which extends to several times the beam injection energy. At the same time, more than half of the entering beam power appears in a continuous, broad spectrum of electrostatic fluctuations, peaked near the plasma frequency, but extending over the entire frequency range of the wave dispersion. A theoretical prediction of this spectrum is developed from a general relation between wave power spectral density and velocity space particle flux. This relation is valid for emission and absorption by resonant wave-particle interactions, and is derived from a basic energy conservation argument applied to wave-particle dynamics with arbitrarily strong perturbation of particle orbits. This relation and the Fokker-Planck coefficients may be used to derive standard results about collisionless (Landau) damping, and spontaneous emission.

FUSION POWER PLANT TECHNOLOGY

38645 (ANL/FPP—77-4) **Fusion Power Program. Quarterly progress report, July—September 1977.** (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 111p. Dep. NTIS, PC A06/MF A01.

Separate abstracts were prepared for each of the 6 included sections. (MOW)

38646 (INIS-mf—3998) **Fusion power in the E.E.C.: some considerations concerning the future programme.** Carruthers, R.; Schmitter, K.H. (UKAEA Research Group, Abingdon. Culham Lab.). 1976. 67p. (CONF-760634—14). Dep. NTIS (US Sales Only), PC A04/MF A01.

From Pacific regional symposium; Seattle, WA, USA (24 Jun 1976).

The problems of fusion reactor technology, the assessment of potential reactor systems and an estimate of the overall investment of manpower likely to be needed to reach a practical fusion power reactor are presented.

38647 **Engineering questions of design of experimental TM-4 reactor.** Borisov, V.P.; Vakhrushin, Yu.P.; Glukhikh, V.A. *Dokl. Vses. Soveshch. Inzh. Probl. Upr. Termoyad. Sint.;* 1: 165-173(1975). (In Russian).

Thermonuclear TM-4 reactor (tokamak-type) is described. It is designed for study of plasma in chamber having wall temperature close to that of reactor wall and for conducting experiments on hf-heating of plasma. Main parameters of the device are: large torus—55 cm, plasma column radius—10 cm, maximum current in plasma—120 kA, plasma confinement time—15 ms, induction of longitudinal magnetic field -4T, pulse repitition rate 1.

38648 (ORNL/TM—6319) **Continuous tokamaks.** Peng, Y.K.M. (Oak Ridge National Lab., Tenn. (USA)). Apr 1978. Contract W-7405-ENG-26. 48p. Dep. NTIS, PC A03/MF A01.

A tokamak configuration is proposed that permits the rapid replacement of a plasma discharge in a "burn" chamber by another one in a time scale much shorter than the elementary thermal time constant of the chamber first wall. With respect to the chamber, the effective duty cycle factor can thus be made arbitrarily close to unity minimizing the cyclic thermal stress in the first wall. At least one plasma discharge always exists in the new tokamak configuration, hence, a continuous tokamak. By incorporating adiabatic toroidal compression, configurations of continuous tokamak compressors are introduced. To operate continuous tokamaks, it is necessary to introduce the concept of mixed poloidal field coils, which spatially groups all the poloidal field coils into three sets, all contributing simultaneously to inducing the plasma current and maintaining the proper plasma shape and position. Preliminary numerical calculations of axisymmetric MHD e uilibria in continuous tokamaks indicate the feasibility of their continued plasma operation. Advanced concepts of continuous tokamaks to reduce the topological complexity and to allow the burn plasma aspect ratio to decrease for increased beta are then suggested.

38649 (UCRL—52000-77-7, pp 1-9) **TMX: a new fusion plasma experiment.** Jul 1977.

In Energy and technology review.

The primary goal of the magnetic fusion energy program at LLL is the development of a technically and economically feasible approach to the generation of fusion energy. Results from our earlier 2XIIB experiment lead us to believe that a fusion power plant based on a mirror system is technically feasible, assuming a favorable extrapolation to plasmas of reactor size. Achieving economic feasibility is more difficult. For power-producing applications, a reactor needs a large Q, the ratio of fusion power output to the power injected to sustain the system. In a conventional mirror reactor, the fusion power is only about equal to the power injected by the neutral beams--that is, Q is only about unity. A new idea, the tandem mirror concept described in this article, promises to increase this gain, enhancing Q by at least a factor of 5.

38650 (UCRL—52000-77-10, pp 1-8) **Mirror Fusion Test Facility.** Dixon, F.P. Oct 1977.

In Energy and technology review.

On October 1, 1977 work began at LLL on the Mirror Fusion Test Facility (MFTF), an advanced experimental fusion device. Scheduled for operation in late 1981, MFTF is designed as an intermediate step between present mirror machines, such as 2XIIB, and an experimental fusion reactor. This design incorporates improved technology and a better theoretical understanding of how neutral beam injection, plasma guns, and gas injection into the plasma region compensate for cooling and particle losses. With the new facility, we expect to achieve a confinement factor (n tau) of 10^{12} particles . sm/cm^3--a tenfold increase over 2XIIB n tau values--and to increase plasma temperature to over 500 million K. The following article describes this new facility and reports on progress in some of the R and D projects that are providing the technological base for its construction.

38651 (ORNL-tr—4602) **Information on thermonuclear research in the USSR.** Kartashev, K.B. (ed.). Translated by S.D. Blalock Jr. from *Nov. Termoyad. Issled. SSSR, Inf. Byull.;* No. 4, 3-23(Dec 1977). 19p. Dep. NTIS, PC A02/MF A01.

This report gives summaries for each of the following areas: (1) quasi-steady-state systems for confining and heating plasma, (2) pulse systems for confining and heating plasma, (3) plasma diagnosis, (4) CTF engineering problems, and (5) conferences, meetings, and symposium. (MOW)

38652 (ORNL-tr—4423) **News of thermonuclear research in the USSR.** Kartashev, K.B.; Volkov, E.D.; Konkashbaeev, I.K.; Mukhovatov, V.S.; Proshin, M.A.; Smirnov, A.P.; Filimonova, E.A.; Shpigel, I.S. Translated by S.D. Blalock Jr. from *Nov. Termoyad. Issled. SSSR, Inf. Byull.;* No. 2, 1-20(1977). 16p. Dep. NTIS, PC A02/MF A01.

Summaries of research carried out in the Soviet Union are included. These cover the following areas: (1) quasi-stationary systems for confining and heating plasma, (2) pulsed systems for confining and heating plasma, (3) fast particle injectors, (4) plasma diagnostics, (5) UTS engineering questions, and (6) high temperature plasma physics. (MOW)

38653 **Adapting the experience of DoD/industry to developing fusion power reactors.** Gough, W.C. (Electric Power Research Inst., Palo Alto, CA); Briggs, W.B. pp 69-75 of New options in energy technology. New York; American Institute of Aeronautics and Astronautics, Inc. (1977).

From Conference on new options in energy technology; San Francisco, CA, USA (2 Aug 1977).

See CONF-770824—.

All fusion research devices to date have been conceived, designed, built and operated by groups that function as research laboratories. Aerospace experience has been infused into this community and has made some worthy contributions. Two aspects of this infusion are described. One is assisting the development planning of new fusion systems by adapting the methods used by DOD/Industry. A number of significant parallels exist and some are discussed. The second infusion is of technology and analysis procedures. Examples of these are described.

38654 **Some engineering problems in designing tokamak-based thermonuclear reactor.** Popov, G.N.; Shatalov, G.E. *Dokl. Vses. Soveshch. Inzh. Probl. Upr. Termoyad. Sint.;* 1: 48-63(1975). (In Russian).

Plans for an experimental thermonuclear reactor is based on tokamak (ETRT). This reactor is designed for experimental proof ot the possibility of designing a thermonuclear reactor. Research has been conducted which is needed to develop industrial equipment with high technical and economic characteristics. A reactor block-diagram is presented and the primary systems are described.

38655 **Primary parameters of the Tokamak-7 reactor.** Ivanov, D.P.; Keylin, V.E.; Klimenko, E.Yu.; Strelkov, V.S. *Dokl. Vses. Soveshch. Inzh. Probl. Upr. Termoyad. Sint.;* 1: 184-188(1975). (In Russian).

The Tokamak-7 device is described. It is the first thermonuclear system with superconductive primary magnetic field winding. The maximum field v of the winding surface H/sub m/ is about 50 kOe; axially h/sub z/ about 30 kOe. With an average winding diameter of about 1 meter, discharge chamber radius a-35 cm, and

large torus radius R-122 cm. Energy reserve in magnetic field is 20 MJ with current density in the winding of about 4,000 A/cm^2.

BLANKET ENGINEERING

38656 (ANL/FPP—77-4, pp 36-50) **Experimental power reactor.** 1977.

In Fusion Power Program. Quarterly progress report, July—September 1977.

New impurity control methods for an EPR are discussed. Superconducting magnet systems for an EPR design are discussed in terms of Ohmic heating coils, equilibrium field coils, and reducing field ripple from toroidal field coils. In addition, some TNS and EPR tritium systems studies are described. (MOW)

38657 (ANL/FPP—77-4, pp 69-83) **Fusion systems engineering.** 1977.

In Fusion Power Program. Quarterly progress report, July—September 1977.

A summary of some completed systems studies is given. Blanket processing technology developments are outlined. Thermal models for the first wall and plasma dump are described. Some cross section measurements, evaluations, and techniques are shown. (MOW)

38658 (IAE—2545) **Vacuum-physical conditions effecting on selection of a material for a first wall and diaphagm of the T-20 demonstration thermonuclear reactor-tokamak.** Gusev, V.M.; Guseva, M.I.; Gervids, V.I.; Kogan, V.I.; Martynenko, Yu.V.; Mirnov, S.V. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1975. 16p. (In Russian). Dep. NTIS (US Sales Only), PC A02/MF A01.

The vacuum coditions are considered affecting choice of material of the first wall and the diaphragm of the T-20 tokamak. By modelling effects of plasma interaction with the wall and entering of impurities requirements are determined to be imposed on the material of the first wall. It must sputter only slightly under the effect of fast neutral hydrogen atoms and must permit effective decontamination so that the electron desorption coefficient of surface impurities does not exceed 10^{-5} molecule/electron at an electron energy of 100 eV. C, Ti, Al, or their compositions have been chosen as the most probable materials. The sputtering coefficients of various materials (Be, Al, Ti, V, Nb, Mo, W, stainless steel) by H^+, D^+, T^+, and He^+ ions as calculated for E = 1 keV.

38659 (IAE—2606) **Axial - asymmetric divertors for a tokamak.** Petrenko, Yu.N.; Popryadukhin, A.P. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1976. 19p. (In Russian). Dep. NTIS (US Sales Only), PC A03/MF A01.

Asymmetric divertors which minimize field weakening on the axis of a Tokamak system (10-20%) are considered. Attention is focused on the choice of the configuration of the divertor magnetic system and on calculation of the resulting topology of the Tokamak field. Model of a toroidal system consisting of infinitely thin discrete coils and a model of straight parallel rods with rectangular cross section used for calculations. It has been established that resonance disturbances of the magnetic surfaces by the divertor do not exceed those reachable in practice. The increase in diffusion coefficient due to superbananas on the particles, locked in the divertor, is insignificant.

38660 (Juel—1435) **Spectrum unfolding from activation measurements in a CTR-model blanket experiment. Comparisons and sensitivity-analysis.** Kuijpers, L.J.M. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorentwicklung). Jul 1977. 89p. Dep. NTIS (US Sales Only), PC A05/MF A01.

Neutron spectra in a lithium fusion reactor model blanket are determined experimentally by performing SAND II unfolding runs from measured activities. The principles of the iterative SAND II method are given and characteristics of the output are described. The spectra are calculated from available data with the aid of a Monte Carlo program, of which procedure numerical results are given. Both kinds of spectra are compared; when number of input data is varied or different cross section data sets are chosen, inconsistencies in activities or cross section data may be detected.

38661 (LA—7053-MS, pp 82-91) **Shutdown problems in large tokamaks.** Weldon, D.M. Jan 1978.

In TNS Doublet tokamak ohmic-heating power supply study.

Some of the problems connected with a normal shutdown at the end of the burn phase (soft shutdown) and with a shutdown caused by disruptive instability (hard shutdown) have been considered. For a soft shutdown a cursory literature search was undertaken and methods for controlling the thermal wall loading were listed. Because shutdown computer codes are not widespread, some of the differences between start-up codes and shutdown codes were discussed along with program changes needed to change a start-up code to a shutdown code. For a hard shutdown, the major problems are large induced voltages in the ohmic-heating and equilibrium-field coils and high first wall erosion. A literature search of plasma-wall interactions was carried out. Phenomena that occur at the plasma-wall interface can be quite complicated. For example, material evaporated from the wall can form a virtual limiter or shield protecting the wall from major damage. Thermal gradients that occur during the interaction can produce currents whose associated magnetic field also helps shield the wall.

38662 **Toroidal tokamak divertor.** Petrenko, Y.N.; Popryadukhin, A.P. *Sov. Phys. - Tech. Phys. (Engl. Transl.);* **22**: No. 7, 829-833(Jul 1977).

Toroidal (axially asymmetric) (toroidal) divertors which only cause a weak perturbation of the field in a tokamak are proposed. The divertor parameters are found analytically and by numerical simulations. It is shown that the resonant perturbations of the magnetic surfaces can be made small. Possible applications of these divertors as magnetic limiters, for achieving heliotron conditions, and for use with ac tokamaks are discussed.

38663 **Poloidal divertor model for tokamak fusion reactors.** Mense, A.T. Madison, WI; Univ. of Wisconsin (1977). 264p. University Microfilms Order No. 77-19,722.

Thesis (Ph. D.).

The work presented here represents a study on magnetic field divertors for fusion reactors. In particular, a model was developed to try to simulate the particle collection effects of a divertor. The model incorporates the effects of an electrostatic sheath at the particle collector plates. This model was incorporated into the plasma transport equations. The entire coupled set of time dependent, nonlinear, particle and energy transport equations, including the divertor model and Maxwell's equations, was solved numerically. The numerical technique used to solve these equations was a Crank-Nicholson differencing algorithm combined with a linearization scheme proposed by Widner and Dory. The fusion reactor plasmas investigated were assumed to have transport properties characterized by the so-called "dissipative trapped particle" modes. The cross field transport in the divertor zone was taken to be Bohm.

38664 **Energy cycles of tokamak reactor.** Lysenko, S.E.; Popkov, G.N. *Dokl. Vses. Soveshch. Inzh. Probl. Upr. Termoyad. Sint.;* **1**: 38-47(1975). (In Russian).

Ionization and accumulation of impurities in the plasma dislodged from the wall causes cyclic operating conditions of a thermonuclear reactor of the tokamak type. Atomization of the wall by neutrons and alpha particles may affect the course of the fuel cycle, if the coefficient of atomization is greater than the coefficient of atomization affected by D and T. Conditions are calculated under which neutral particles and cool D—T mixture are injected to maintain constant temperature and concentration of working medium, and consequently, nuclear energy output.

MAGNET COILS AND FIELDS

REFER ALSO TO CITATION(S) 37663, 37713, 38656

38665 (ANL/FPP—77-4, pp 51-68) **TNS project.** 1977.

In Fusion Power Program. Quarterly progress report, July—September 1977.

Some cable studies for the development of cryostable superconducting pulsed coils for the TNS project are reported. A large fiberglass-reinforced plastic dewar is described. In addition, brief descriptions of research work are given on the limits on B for a graded OH solenoid, and on penetration shield analysis. (MOW)

38666 (ORNL/TM—6279) **Simulation of poloidal divertors in one-dimensional tokamak transport codes.** Mense, A.T.; Emmert, G.A. (Oak Ridge National Lab., Tenn. (USA); Wisconsin Univ., Madison (USA)). Apr 1978. Contract W-7405-ENG-26. 51p. Dep. NTIS, PC A04/MF A01.

The two-dimensional effect of plasma flow along the field lines in the scrape-off zone of a poloidal divertor has been modeled phenomenologically in a one-dimensional tokamak transport code. Some results of the profiles in the scrape-off zone, as well as in the main plasma, are given in this paper. These calculations suggest some approximations, which have been used to develop a zero-dimensional model of the divertor.

38667 **Mirror power reactor magnet coil system: a technically and economically feasible design.** Peterson, M.A. Davis, CA; Univ. of California (1977). 320p. University Microfilms Order No. 77-27,363.

Thesis (Ph. D.).

The design and preliminary engineering analysis of a "Yin Yang" coil system utilizing several original design concepts to achieve technical and economic feasibility will be presented. The design analysis is begun with a general description of the constraints and prerequisites which define the problem of designing a satisfac-

tory coil system for a mirror power reactor. This description includes a discussion of the coil conductor geometry required by plasma physics considerations, and also a description of the magnitude and direction of the magnetic force system distributed over the conductor geometry. In addition, the important design constraints which all mirror coil system designs must satisfy if they are to successfully interface with the other reactor components are reviewed. After considering the basic constraints that Yin Yong coil systems must be developed around, a survey of the various design concepts that were developed and explored in search of a satisfactory coil system design is discussed. From this extensive preliminary investigation of potential coil system configurations, a coil system design was developed which appears to offer by far the best combination of technical and economic feasibility of any other coil system design developed thus far.

POWER SUPPLIES, ENERGY STORAGE

38668 (ANL/FPP—77-4, pp 84-89) **Magnetic systems.** 1977. In Fusion Power Program. Quarterly progress report, July—September 1977.

The energy storage and transfer system are briefly described. Some preliminary testing is reported. Two negative ion sources are discussed. The first is a charge exchange H^- source. The second is a direct extraction H^- source. (MOW)

38669 (LA—7053-MS) **TNS Doublet tokamak ohmic-heating power supply study.** Rogers, J.D. (comp.). (Los Alamos Scientific Lab., N.Mex. (USA)). Jan 1978. Contract W-7405-ENG-36. 97p. Dep. NTIS, PC A05/MF A01.

Separate abstracts were prepared for each of the six included sections. (MOW)

38670 (LA—7053-MS, pp 1-19) **Circuit analysis and operating cycle.** Vogel, H.F. Jan 1978.

In TNS Doublet tokamak ohmic-heating power supply study.

The E-coil circuit is analyzed numerically, where the inductance matrix is obtained from the geometry of the TNS Doublet and the average plasma resistance from the 8-Vs number reported for the current reversal. The homopolar machine's and connecting bus's resistances are estimated and the circuit is discussed. Design equations are derived for a homopolar machine featuring movable brushes. The circuit still requires a dedicated power supply for the burn period because the kinetic energy can only be partially transferred to the external circuit if the terminal voltage is varied by movable brushes. The energy remaining in the machine may, however, be used as a control element during the entire current reversal. The maxima in electromagnetic stress in E-coils thus become equalized over the pulse cycle.

38671 (LA—7053-MS, pp 20-28) **Damped LC circuit for the ohmic-heating coils of TNS Doublet.** Vogel, H.F. Jan 1978.

In TNS Doublet tokamak ohmic-heating power supply study.

Equations for the currents and voltages of a damped LC circuit are reviewed for the two conditions of (a) the initially charged capacitor and (b) the initially charged inductor. The energy transfer efficiency, maximum voltage, and resistance are plotted for the TNS case with 2-s energy transfer time, 500-MJ inductive energy and current maxima of 1, 2, and 3 MA. The brush loss is calculated for the case that the capacitor is a homopolar machine.

38672 (LA—7053-MS, pp 29-60) **Homopolar machine design.** Thullen, P. Jan 1978.

In TNS Doublet tokamak ohmic-heating power supply study.

A general conceptual design for a disc-type homopolar machine is presented. This machine uses a superconducting, air-core, solenoidal field winding with a peak field of 8 T. A total energy of 500 MJ is stored in two counter-rotating disc rotors that operate at a surface speed of 200 m/s. Terminal voltages of 500 to 2000 V are obtained over the range of designs studied. Brush systems to collect 3 MA are investigated. Various brush materials are discussed to determine their usefulness in this application. Sufficient information on operating characteristics in high-power applications is only available for copper-graphite brus es. The use of sliding brushes for terminal voltage regulation is discussed. This feature cannot provide a great deal of flexibility in this particular application although it may be useful during start-up. The brush system is the most demanding feature of this design. Few systems in the million ampere range have been constructed, consequently, it is not possible to predict the behavior of this brush system with great certainty. A detailed design of the brushes should be undertaken. It is estimated that the cost of such a machine will range from 0.5 to 1.5 cents per joule.

38673 (LA—7053-MS, pp 61-75) **Ferromagnetic rotor homopolar machine for a 3.0-MA ohmic-heating power supply.** Bird, W.L.; Weldon, W.F. Jan 1978.

In TNS Doublet tokamak ohmic-heating power supply study.

A conceptual engineering design study was performed to characterize an iron dominated, normal copper field coil excited homopolar machine for the General Atomic TNS Doublet tokamak fusion reactor. Inertial energy transfer efficiency of 90% for the ohmic-heating start-up cycle was used to determine the machine parameters. The resulting pulsed power supply requires two interconnected, single rotor homopolars in the drum configuration. The 500-V, 500-MJ, 2-s energy transfer period system costs range from 8.4 mils/J for the two homopolars alone to 16.4 mils/J if in the latter case rotor peripheral speed must be reduced and slot and wedge ac generator technology is used.

38674 (LA—7053-MS, pp 76-81) **Circuit breaker and bus.** Vogel, H.F. Jan 1978.

In TNS Doublet tokamak ohmic-heating power supply study.

Two close-open operations are required each pulse cycle at approximately 3 MA with the breaker in series with the burn supply, both forming a leg in parallel with the E-coil and the homopolar. To conduct the 3-MA current, approximately 30 breaker units are connected in parallel. Each unit is equipped with a counterpulse capacitor bank, and the bus for the 30 units is provided with a common saturable reactor core made of strip steel wound around the bus. Oil breakers of a special design are chosen because of their high arc resistance facilitating the current transfer to the homopolar machine and for obtaining precision timing in opening and closing of the contacts. The precision timing is achieved by a shock wave method with the oil serving as hydraulic medium. Each of the parallel breaker units possesses two sets of contacts, a stationary and a transient one. A 1-mΩ resistor in series with the transient contacts of each breaker unit is to improve the current sharing. The bus consists of room temperature copper, stranded and transposed to help provide current equalization under transient conditions.

COOLING SYSTEMS

38675 (CLM-R—174) **Feasibility of remotely separating and rejoining the main coolant pipes of a fusion reactor.** Briaris, D.A.; Stanbridge, J.R. (UKAEA Research Group, Abingdon. Culham Lab.). Sep 1977. 30p. Dep. NTIS (US Sales Only), PC A03/MF A01.

The generic requirement of a fusion reactor that the first wall and other high neutron dose structures be periodically replaced gives rise to a number of complex engineering operations which need to be performed remotely and with a high degree of reliability. Techniques for the remote separation and rejoining of the helium coolant pipes on the Culham Conceptual Tokamak Reactor Mk. II have been investigated in the form of cutting and welding schemes and the use of a mechanical coupling. A mechanical coupling is the more attractive because the reduced complexity of the operations to separate and join the pipes potentially shortens the reactor down-time. Some assessment of remote joint examination and recovery from faults has also been made.

HEATING AND FUELING SYSTEMS

REFER ALSO TO CITATION(S) 38668

38676 (IPP—4/159) **Neutral injection requirements and parameters for the ASDEX Tokamak.** Staebler, A. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (Germany, F.R.)). Jun 1977. 36p. Dep. NTIS (US Sales Only), PC A03/MF A01.

Neutral injection is planned as an additional heating method for the ASDEX tokamak. The required input power and the appropriate extraction voltage are determined by evaluatinT the beam penetration, the heating efficiency, the impurity increase associated with neutral injection and the net particle current added to the plasma. The calculations deal with the following items: beam absorption and fast ion confinement, radial particle deposition, slowing-down on plasma ions and electrons, losses due to charge exchange during beam trapping and fast ion slowing-down and (in a rather simplified way) the presence of a loss region. As a result of these calculations the following design parameters are proposed: extracted ion current: 4 x 40 A, extraction voltage: 40-50 kV, pulse length: 0. - 1.0 s. Assuming reasonable values for an ASDEX plasma, this will yield the following performance: power transferred to the plasma: approximately 2.5 MW, power to the ions: approximately 1.5 MW, impurity increase: ΔZsub(eff) approximately 1.0-1.5 and particle refuelling: $>$ 35 A. Furthermore, the possibility of varying the heating power profiles by changing the injection geometry is investigated.

38677 (IPP—4/160) **Pellet ablation in hot plasmas and the problem of magnetic shielding.** Lengyel, L.L. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (Germany, F.R.)). Apr 1977. 39p. Dep. NTIS (US Sales Only), PC A03/MF A01.

Theories published on pellet ablation phenomena are reviewed. Some inconsistencies are shown to exist in some of the

studies available. Models are developed and estimates are given for pellet ablation rates in hot plasmas with and without magnetic fields present. The possible existence of a self-regulating ablation mechanism is indicated.

38678 **New generation of multicharged heavy ion sources.** Baron, E. (Grand Accelerateur National d'Ions Lourds (GANIL), 14 - Caen (France)). *J. Phys. (Paris), Colloq.;* No. 3, C.89-C.97(1977). (In French).

From National congress on plasma physics; Paris, France (6 - 10 Dec 1976).

An attempt is made to visualize the present situation of some multicharged ion source developments (electron beam, electron cyclotron resonance and laser sources). First are reminded the interest of getting charge states higher than that delivered by the classical sources, along with the ionization by electronic impact state-of-the-art. Then, a brief description of the principles of these new sources and an account of the present performances are given. Finally, an attempt is made to compare these performances and to predict the most suitable type of accelerator to each of these sources.

38679 (UCID—17581) **Low energy components from charge transfer in neutral beams for fusion.** Anderson, O.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 Mar 1977. Contract W-7405-ENG-48. 39p. Dep. NTIS, PC A03/MF A01.

The MFTF/TFTR injector system is studied. The LLL double charge exchange system is also studied. The stripping problem in surface-production negative ion systems producing beam energies up to 1000 keV is also investigated. (MOW)

38680 (UCID—17581(Rev.1)) **Parasitic components from charge transfer in neutral beams for fusion.** Anderson, O.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 Feb 1978. Contract W-7405-ENG-48. 37p. Dep. NTIS, PC A03/MF A01.

Charge exchange within accelerating grids in neutral beam systems produces parasitic beam components which degrade the performance of the systems. These components also change the plasma confinement properties at the target. This note discusses parasitic beams produced in three types of grid systems: (1) TFTR/MFTF sources, (2) accel-decel grids for low energy beams, and (3) the JSC negative ion system.

38681 **Critical impurity concentrations for ignition of catalyzed-deuterium fusion plasmas.** Jensen, R.V.; Jassby, D.L.; Post, D.E. (Princeton Univ., NJ). *Nucl. Sci. Eng.;* **66**: No. 1, 144-146(Apr 1978).

The maximum concentrations, f/sub zc/, of various impurity species that permit ignition of catalyzed-deuterium fusion plasmas have been calculated. If cyclotron radiation is negligible, the values of f/sub zc/ at 35 keV, where the fusion power density is maximum, are approximately one-fifth of the values allowed for deuterium-tritium ignited plasmas at 14 keV. For any impurity species, the allowed f/sub zc/ decreases nearly linearly with increasing cyclotron radiation loss.

TRITIUM PROCESSING, ENVIRONMENT AND SAFETY

38682 **Feasibility of chemical getter beds in scavenging tritium from inert gases.** Maienschein, J.L. (Univ. of California, Livermore). *Nucl. Technol.;* **38**: No. 3, 387-404(May 1978).

Chemical getters can be used to scavenge tritium from inert gases. Cerium, which forms a hydride with a low dissociation pressure, has a high reactivity and is relatively inexpensive. It is a good candidate getter material for such a scavenger system. Mathematical models for fixed and fluidized bed reactors predict satisfactory performance. Therefore, the gettering concept warrants further investigation.

38683 **Experimental verification of tritium control by glove-box containment.** Wittenberg, L.J. (Mound Lab., Miamisburg, OH). *Nucl. Technol.;* **38**: No. 3, 434-440(May 1978).

Concepts being developed for tritium containment at proposed fusion power plants will rely on existing laboratory experiences. The successful operation of a glove-box containment system was demonstrated by the control of an accidental release of 0.65 PBq (1.75×10^4 Ci) of tritium to the glove-box atmosphere. The total gaseous release to the environment was 79 +- 10 GBq (2.2 Ci). In addition, the tritium concentration in the body fluids of the sole worker in the laboratory increased by only 74 kBq/l (2 μCi/l). The appearance rate of tritium in the room and the absorption of tritium by the worker were adequately described by permeation of the molecular species of T_2 and HTO through the gloves.

POWER CONVERSION SYSTEMS

38684 (UCRL—50039-77-3) **Advanced-fueled fusion reactors suitable for direct energy conversion. Third and fourth quarterly progress reports, July 1977—December 1977.** Blum, A.S. (ed.). (California Univ., Livermore (USA). Lawrence Livermore Lab.). 31 Jan 1978. Contract W-7405-ENG-48. 21p. Dep. NTIS, PC A02/MF A01.

The design procedure is described for the 120-kV, helium-3 accel-decel grid system. In addition, highlights are presented of the final injector design. The ion current density is limited by sputtering and a required 180-day operating life. We also note that we have successfully vacuum pumped helium-3 at near black-hole speeds by cryotrapping.

INERTIAL CONFINEMENT TECHNOLOGY

REFER ALSO TO CITATION(S) 37839, 37840, 37841, 37852, 37906

38685 (IAE—2624) **Conductive shells compression in pusle high magnetic fields.** Andrianov, A.M.; Alekseev, Yu.A.; Baryshev, V.L.; Kaseev, M.N.; Kisula, V.V. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1976. 25p. (In Russian). Dep. NTIS (US Sales Only), PC A03/MF A01.

The results are presented of a study into the dynamics of compression of cylindrical shells accelerated by pulsed magnetic fields up to 600 kOe obtained on discharge of a condenser bank through a one-turn solenoid. Attention has been focused on the correlation of shell parameters with those of the electric circuit of a power supply at which the most efficient conversion of electrical energy to the kinetic energy of the shell is achieved. A problem is formulated and solved on a computer taking into account the nonlinear diffusion of the magnetic field into the shell, the effect of the shell motion on the current in the electric circuit of the power supply and energy losses due to plastic deformation of the shell. To verify the calculation results an experimental investigation of shell compression has been carried out.

38686 (UCID—17754) **Nonlinear propagation in fusion laser systems.** Bliss, E.S.; Glass, A.J.; Glaze, J.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Nov 1977. Contract W-7405-ENG-48. 26p. Dep. NTIS, PC A03/MF A01.

This report was assembled to provide a brief review of the historical development of the study of self-focusing and nonlinear light propagation and its impact on the design of large, Nd-glass lasers for fusion research. No claim to completeness is made, but we feel that the enclosed summary does not miss many of the major developments in the field.

38687 (UCRL—50021-76) **Laser Program annual report, 1976.** Coyle, P.E. (ed.). (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jun 1977. Contract W-7405-ENG-48. 1070p. Dep. NTIS, PC A99/MF A01.

Separate abstracts were prepared for each of the 8 included sections. (MOW)

38688 (UCRL—50021-76, pp 1.1-1.9) **Program overview.** Jun 1977.

In Laser Program annual report, 1976.

The program overview describes the following resources and facilities; laser facilities, main laser room, target room, energy storage, laboratory area, building support systems, general plant project, and the new trailer complex. (MOW)

38689 (UCRL—50021-76, pp 3.1-3.142) **Fusion experiments program.** Jun 1977.

In Laser Program annual report, 1976.

This section gives data on the designing, performing, and analyzing experiments with targets irradiated by high-intensity lasers. Detailed information is given for the following areas: (1) the experimental facilities, (2) diagnostics development, (3) optical diagnostics, (4) x-ray diagnostics, (5) particle diagnostics, and (6) real-time data and control systems. (MOW)

38690 (UCRL—50021-76, pp 4.1-4.193) **Fusion targets.** Jun 1977.

In Laser Program annual report, 1976.

This section deals with the design and fabrication of targets and the computer simulation of laser fusion experiments. The following research areas are discussed: (1) laser target design and analysis, (2) electron and ion beam target design and analysis, (3) LASNEX: overview, (4) laser plasma theory and simulation, (5) theory and simulation: laser light absorption, (6) heated electron energies, (7) heat transport, and (8) target fabrication. (MOW)

38691 (UCRL—50021-76, pp 5.1-5.160) **Progress toward laser fusion.** Jun 1977.

In Laser Program annual report, 1976.

As part of the ongoing effort to understand the physics of laser-imploded targets, a series of experiments examining a wide range of irradiation geometries and intensities have been performed over the last two years, both at Livermore and other laboratories. At Livermore these include experiments designed to study the basic

laser plasma interaction phenomena, as well as experiments specifically designed to map out and understand the parameter space and physics of laser-induced compressions of thermonuclear fuel. This section discusses the experimental results obtained with DT-filled SiO_2 microshell exploding pusher targets at the Lawrence Livermore Laboratory using the Janus, Cyclops, and Argus laser facilities in both one- and two-beam configurations. The experiments were performed using f/1 and f/2.5 lenses and the lens-elliptical-mirror-spherical illumination system at power levels ranging from 0.2 to 4.5 TW.

38692 (UCRL—50021-76, pp 7.1-7.57) **System studies and applications.** Jun 1977.

In Laser Program annual report, 1976.

Extensive information is given for each of the following topics: (1) fusion reactor studies, (2) reactor concepts, (3) first wall studies, (4) laser system studies, (5) fusion-fission hybrids, (6) National security applications, and (7) long-range planning for inertial confinement fusion. (MOW)

38693 **Impedance characteristics of heated REB diodes.** Johnson, D.J. (Sandia Laboratories, Inc., Albuquerque, New Mexico 87115). *Appl. Phys. Lett.;* **32**: No. 10, 614-616(15 May 1978).

The influence of anode and cathode plasma upon the behavior of low-impedance REB diodes is investigated by acquiring data with anodes and cathodes heated to 1000 and 200 °C, respectively. These data indicate a reduction in impedance collapse which is consistent with a 20% reduction in the anode-cathode plasma gap closure velocity and a factor of 2.5 reduction in ion current. The ion current is reduced for heated anodes because then the ion current is primarily attributed to weakly ionized carbon and higher atomic number ions rather than protons.

38694 **Scaling of nonthermal ion energy in laser-generated plasma.** Waegli, P.; Donaldson, T.P.; Laedrach, P. (Institute of Applied Physics, University of Berne, CH-3012 Berne, Switzerland). *Appl. Phys. Lett.;* **32**: No. 10, 638-640(15 May 1978).

Plasma was generated by focusing a 1.06-μm 35-psec laser pulse obliquely onto a solid surface at the optimum resonance absorption angle. The scaling of nonthermal ion emission energy with laser intensity was determined. A computer model for resonance absorption showed nonthermal ion emission to be due to electron acceleration by a resonantly driven electrostatic field.

38695 **Enhanced stimulated Raman scattering does not exist.** Eimerl, D. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *Phys. Rev. Lett.;* **40**: No. 14, 934-938(3 Apr 1978).

A recent Letter by Sparks ad Sen challenges the viability of a recently proposed design for a commerical laser-fusion power plant. The basis for this challenge is the controversial theory of enhanced stimulated Raman scattering put forward by Sparks. This theory has been examined carefully. It is found to be in direct contradiction to be both the classical and quantum theories of stimulated Raman scattering, and it is also in serious conflict with many experimental results.

38696 **Possible impact of laser fusion on the utility industry.** Gomberg, H.J. (KMS Fusion, Inc., Ann Arbor, MI). pp 68 of New options in energy technology. New York; American Institute of Aeronautics and Astronautics, Inc. (1977).

From Conference on new options in energy technology; San Francisco, CA, USA (2 Aug 1977).

See CONF-770824—.

Laser fusion is fast becoming an important candidate in advanced technology to supply a significant portion of the future energy needs of the United States as our domestic energy resources of gas and petroleum become depleted. In laser fusion the energy is generated in many successive small steps as in an internal combustion engine. Fusion of deuterium and tritium gives promise of nearly unlimited energy for the future. It appears that laser fusion should be able to provide an economic unit at levels as low as 100 MW. Such systems could thus furnish the power for communities at the substation level.

COMPONENT DEVELOPMENT AND MATERIALS TESTING

REFER ALSO TO CITATION(S) 37886

38697 (ANL/FPP—77-4, pp 1-35) **Fusion reactor materials.** 1977.

In Fusion Power Program. Quarterly progress report, July—September 1977.

Some experimental results are presented for each of the following topics: (1) an accelerator system for producing two-component beams for studies of interactive surface effects, (2) surface damage of molybdenum and TZM alloy under D^+ impact, (3) ion nitriding of titanium and zirconium by a dc discharge method, (4) dosimetry and damage analysis work, (5) hydrogen permeation and materials behavior in alloys, (6) irradiation-induced void swelling and solute segregation in a heavy-ion irradiated V-15 wt percent Cr alloy, (7) microstructural development during irradiation, and (8) radiation damage of diagnostic windows in TFTR. (MOW)

38698 (DOE/ET—0015) **Special purpose materials for the fusion reactor environment: a technical assessment.** (Department of Energy, Washington, D.C. (USA). Office of Magnetic Fusion Energy). Feb 1978. 114p. Dep. NTIS, PC A06/MF A01.

This technology assessment considers the following areas: (1) breeding materials, (2) coolants, (3) tritium barriers, (4) graphite and silicon carbide, (5) ceramics, (6) heat-sink materials, and (7) magnet materials. Some questions and analyses forming the assessment are described. (MOW)

38699 (IPP—4/155) **Cost sensitivity analysis of possible fusion power plants.** Buende, R. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (Germany, F.R.)). Apr 1977. 28p. Dep. NTIS (US Sales Only), PC A03/MF A01.

A reference design was used in preparing a mathematical model of a fusion power plant with a Tokamak reactor to investigate the extent to which the uncertainty still inherent in the physical reactor parameters affects the power costs. While only limited reductions of the power costs are achieved by improvements of the reference values for the reactor burn time, power density in the torus and load on the first wall, the power costs rise in keeping with the extent to which these parameters fall short of the reference values. As the results obtained in present-day experiments are still well below the reference values, a great deal of effort is still required in the fields of plasma physics and materials research to achieve an economically operating fusion power plant.

38700 (PPPL—1424) **Algorithm for locating the extremum of a multi-dimensional constrained function and its application to the PPPL Hybrid Study.** Bathke, C. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Mar 1978. Contract EY-76-C-02-3073. 55p. Dep. NTIS, PC A04/MF A01.

A description is presented of a general algorithm for locating the extremum of a multi-dimensional constrained function. The algorithm employs a series of techniques dominated by random shrinkage, steepest descent, and adaptive creeping. A discussion follows of the algorithm's application to a "real world" problem, namely the optimization of the price of electricity, P/sub eh/, from a hybrid fusion-fission reactor. Upon the basis of comparisons with other optimization schemes of a survey nature, the algorithm is concluded to yield a good approximation to the location of a function's optimum.

38701 **Application of simulation experiments to fusion materials development.** Nolfi, F.V. Jr. (Argonne National Lab., IL); Li, C.Y. *Nucl. Technol.;* **38**: No. 3, 405-414(May 1978).

One of the major problems in the development of structural alloys for use in magnetic fusion reactors (MFRs) is the lack of suitable materials testing facilities. This is because operating fusion reactors, even of the experimental size, do not exist. A primary task in the early stages of MFR alloy development will be to adapt currently available irradiation facilities for use in materials development. Thus, it is generally recognized that, at least for the next ten years, studies of irradiation effects in an MFR environment on the microstructure and mechanical properties of structural materials must utilize ion and fission neutron simulations. Special problems will arise because, in addition to displacement damage, an MFR radiation environment will produce, in candidate structural materials, higher and more significant concentrations of gaseous nuclear transmutation products, e.g., helium and hydrogen, than found in a fast breeder reactor. These effects must be taken into account when simulation techniques are employed, since they impact heavily on irradiation microstructure development and, hence, mechanical properties.

38702 **Calculated atom displacement and gas production rates of materials using a fusion reactor first wall neutron spectrum.** Gabriel, T.A.; Bishop, B.L.; Wiffen, F.W. (Oak Ridge National Lab., TN). *Nucl. Technol.;* **38**: No. 3, 427-433(May 1978).

The displacement per atom and gas production rates have been calculated for a number of alloys and elements using a design neutron spectrum at the first wall of a fusion reactor. These rates can be combined for most alloys to yield the defect production rates, the parameters currently used to extrapolate available irradiation effects data to fusion reactor conditions. Calculated rates of atom displacement and hydrogen generation in stainless steels are relatively insensitive to recent changes in the nuclear data files and to neutron spectrum differences produced by slight reactor design changes. In contrast, the helium production rate is sensitive to these changes and to the exact alloy composition. Composition variation within the specification range for Type 316 stainless steel can produce variations of +-9% in the helium generation rate.

GENERAL AND MISCELLANEOUS

MANAGEMENT

REFER ALSO TO CITATION(S) 38715

38703 (DOE/ER—0003(78)) **Research projects in the physical sciences.** (Department of Energy, Washington, D.C. (USA)). Apr 1978. 34p. Dep. NTIS, PC A03/MF A01.

The research programs under the cognizance of the Office of Energy Research (OER) consist primarily of fundamental theoretical and experimental investigations designed to support the objectives of the Department of Energy (DOE) . These programs are directed toward discovery of natural laws and new knowledge, and to improved understanding of the physical sciences as related to the development, use, and control of energy. The ultimate goal is to develop a scientific underlay for the overall DOE effort and the fundamental principles of natural phenomena so that these phenomena may be understood and new principles formulated. The OER outlay activities comprise three major programs: High Energy Physics, Nuclear Physics, and Basic Energy Sciences which comprises five activities: nuclear sciences; materials sciences; chemical sciences; engineering, mathematical and geosciences; and advanced energy projects. These programs represent about 30 percent of the Nation's Federal support of basic research in the physical sciences. (RWR)

38704 (DOE/IR—0008) **Activities of the Department of Energy in energy education: a description of programs for schools of the Department of Energy and its predecessor agencies.** (Department of Energy, Washington, D.C. (USA)). Mar 1978. 71p. TIC.

This report describes the various programs the Department of Energy and its predecessor agencies have administered for the Nation's schools. It will help to answer some of the questions raised by the public as to what the Federal Government, and the Department of Energy in particular, have done and are doing to prepare the U.S. citizenry to meet the energy challenges of the future. It will also assist school administrators, educational planners, and DOE program managers by identifying worthwhile education programs. These include, not only education per se, but also the development of new energy resources and improved energy conservation efforts. The report includes programs of the Atomic Energy Commission, the Federal Energy Administration, the Energy Research and Development Administration, and the Department of Energy. There are five major areas in which the Department of Energy and its predecessors have played a significant role in supporting and coordinating education related programs in the U.S. These areas are training, curriculum development, educational special events, facilities support, and the Energy Extension Service. 1 figure, 13 tables. (RWR)

38705 (K/CSD/TM—18) **BUDGET: a program for evaluating a project's budget over several years. Phase I user's manual.** DeLozier, R.C. (Oak Ridge Gaseous Diffusion Plant, Tenn. (USA)). Dec 1977. Contract W-7405-ENG-26. 89p. Dep. NTIS, PC A05/MF A01.

The BUDGET program was developed to provide a computer-based method of preparing and documenting a project's money allocation over some time interval. This interactive program is intended to simplify the task of analyzing many subalternatives, such as those concerned with design and specification, before a major project is finalized. In summary, it was designed to aid in making decisions as to how much and where resources will be allocated. Resources or money can be allocated by BUDGET in 50 cost accounts for up to 18 time periods. The number of cost accounts can be expanded easily; however, in order to use the maximum time capabilities that are provided, a printer capable of 158 characters per line is used. Line printers with less capability simply restrict the number of periods that can be studied in one calculation; a 133-characters-per-line printer accommodates 14 periods, and an 80-characters-per-line printer can produce only a seven-period study. An example set of data is provided with the program, and several example problems shown in this report are run using this sample budget. A second set of example problems is formed around the creation of a new budget. The program and example data file are available on the real-time PDP-10 computer system located at the Oak Ridge National Laboratory and are compatible with phone-coupled terminals produced by many vendors (several terminal types are shown along with output results). 36 figures.

38706 (KFK—2450) **Report on the activity of the institutes and departments in 1976.** (Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (Germany, F.R.)). Feb 1977. 386p. (In German). Dep. NTIS (US Sales Only), PC A17/MF A01.

This is the scientific annual report 1976 of the GfK on R and D activities of institutes and departments. It is subdivided into organizational units. The appropriate contributions have been written by the institutes and departments in sole responsibility. The report records the activities of organizational units in the field of science and technology, and presents the results achieved by these units within the framework of the GfK research program.

38707 (UCRL—52000-77-7) **Energy and technology review.** Shay, H.D. (ed.). (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jul 1977. Contract W-7405-ENG-48. 38p. Dep. NTIS, PC A03/MF A01.

A separate abstract was prepared for each of the four articles in this report. (RWR)

MATHEMATICS AND COMPUTERS

38708 (LA—7095-MS) **New probability distribution with applications in Monte Carlo studies.** Johnson, M.E.; Johnson, M.M. (Los Alamos Scientific Lab., N.Mex. (USA)). Jan 1978. Contract W-7405-ENG-36. 12p. Dep. NTIS, PC A02/MF A01.

A new symmetric univariate probability distribution is proposed. Several properties are derived, and the applicability of the distribution to Monte Carlo studies is discussed. 2 figures, 1 table.

38709 (TID—27608/1) **ERROR.** Potter, R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 19 Aug 1976. 9p. (UR—109(Rev.1)). Dep. NTIS, PC A02/MF A01.

ERROR obtains a dump of a controllee or drop file or defines ORDERLIB- or system-detected errors. It is a controllee designed to be run within the ORDER system as part of the ORDER error procedure, or to be run as a specialized dump routine from a teletypewriter. As a stand-alone controllee, ERROR has great versatility. It has options to take full memory dumps, or to give a brief description of errors. ERROR is used to take memory dumps in either decimal or octal, to take partial memory dumps of either software- or hardware-detected errors. It can be run on CDC 7600 and 6600 computers, and uses about 15000_8 memory locations. The major change in this revision is the addition of symbolic dump capability. 1 table (RWR)

38710 (TID—27609/1) U. Archuleta, M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 19 Jul 1976. 15p. (UR—602(Rev.1)). NTIS $3.50.

U is a powerful, simplifying utility routine which eliminates much of the time-consuming and repetitive interaction between you (the user) and other utility routines, compilers, etc. The routine monitors the user's file index and available machine time, and provides effective communication to other users. You can type brief, succinct commands to initiate processing because U associates often-used systems functions or routines with a shortened code name; you can execute these commands simply by typing the command letter. It occupies 15126_{10} memory locations on the CDC 7600. 1 figure. (RWR)

38711 (UCID—17741) **Decomposition of crossed polygons into simple ones.** Dubois, P.F.; Warshaw, S.I.; Keepler, M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Feb 1978. Contract W-7405-ENG-48. 29p. Dep. NTIS, PC A03/MF A01.

In simulation calculations containing finite polygonal mesh elements which deform as the simulation progresses, the mesh may become so entangled that crossed polygons may occur. An algorithm is given for decomposing any crossed polygon into a collection of simple ones; the algorithm allows a consistent interpretation of the area of the polygon, so that available overlap techniques for simple polygons may then be employed. This technique is efficient and unique in a certain sense. 13 figures.

38712 (UCID—17748) **Data Director user's manual.** McGoldrick, P.R.; Butner, D.N. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 21 Feb 1978. Contract W-7405-ENG-48. 48p. Dep. NTIS, PC A03/MF A01.

The Data Director is a multi-user timesharing computer system which allows file manipulation (i.e., editing, printing, punching, etc.) and file transport between it and the OCTOPUS computer system. The heart of the Data Director is an Interdata 7/16 HSALU minicomputer with a 10-Megabyte disk. Data Director users use 9600 baud CRT terminals to interact with the Data Director. The main purposes of the Data Director are to provide a fast, stable, and reliable system for editing and to provide remote punching of files.

38713 **Nonlinear realizations of the direct product of two Lorentz groups on a skew-symmetric tensor space.** Dalton, B.J. (Ames Laboratory-USDOE and Department of Physics, Iowa State University, Ames, Iowa 50011). *J. Math. Phys. (N.Y.);* **19**: No. 6, 1335-1339(Jun 1978).

In this paper, we present a study of exact, infinitesimal, nonlinear realizations of the direct product ($L_1 \times L_2$) of two Lorentz groups on an antisymmetric tensor space eta. Included in this study is a detailed discussion of the second order $(L_1 \times L_2)/L^+$ coset

realizations where L^+ is the symmetric Lorentz subgroup. Invariant metric forms defined on eta are exhibited and compared with invariant metric forms obtained in some previous studies of coset realizations.

38714 Design and implementation of a simple programming language for microcomputers. Cleaveland, J.C.; Satten, C.D. (Univ. of California, Los Angeles). *UCLA Computer Science Quarterly;* 5: No. 1, 61-76(Jan 1977).

GAMMA is a simple, interactive, expression-oriented programing language which grew out of a microcomputer development environment at UCLA. The language, its design, and its implementation are described. GAMMA has three types of values: numbers, strings, and an undefined value, which is used for denoting errors. Numbers are variable-precision decimal floating point and strings are of variable length. The only limitations on the number of digits of precision or string length is the amount of memory available. Memory management is automated leaving ease of use and response time as a user's only concerns. The major design goals of GAMMA were simplicity of the language and an easy implementation on a microcomputer. 1 figure, 3 tables.

INFORMATION HANDLING

38715 (LA-UR—78-628) **Strategic planning for automation within an information services department.** Cooper, P.P.; Hall, J.W. (Los Alamos Scientific Lab., N.Mex. (USA)). 1978. Contract W-7405-ENG-36. 14p. (CONF-780530—1). Dep. NTIS, PC A02/MF A01.

From ASIS mid-year meeting; Houston, TX, USA (22 May 1978).

Today there is a growing trend within organizations for departments to become "islands of mechanization." Departments compete for machine and personnel resources in order to develop individualistic, automated systems which frequently overlap in data content. To avoid this trend and prevent development of future "islands," organizations must emphasize management of in-house information systems to improve the economy of operations, meet organizational objectives more effectively, and control operations more efficiently. The method by which these goals can be realized is formal planning. Planning for information systems becomes the key to the present and future. The longer planning is delayed, the more costly it will be to combine, modify, and standardize existing subsystems into an integrated systems design. There are many different types of plans which can be developed, e.g., short-, medium-, and long-term plans. However, long-term or strategic planning is the most important, as it determines an organization's major objectives. Once objectives have been defined, policies and strategies can be developed for resource allocation to meet those objectives. Action plans will implement the strategies and make the objectives become a reality. A plan for data processing support for the Information Services Department at the Los Alamos Scientific Laboratory is described. The plan is an attempt to unify automation efforts within the Department and insure future planning. Department organization, concerns which led to plan development, background research which went into the plan, and, finally, the plan itself are described including major objectives, strategies, and plans of action.

38716 Generalized data management systems and scientific information. Paris; OECD Nuclear Energy Agency (1978). 347p. (In English and French). (CONF-771062—;CONF-770154—). Publications Center, Washington, DC.

From OECD/NEA working group on nuclear information; Berkeley, CA, USA (5 Oct 1977).

Separate abstracts were prepared for 19 of the papers in this volume. Four additional papers have already been cited in ERA; these can be found by referring to CONF-771062-- in the Report Number Index. Five other papers were not in the scope of coverage of ERA; these dealt with an introduction to generalized data management systems and capabilities required of them in handling data, a programming language for data bases, and specialized applications of data bases to laboratory animals (environmental husbandry, hematology, clinical chemistry) and environmental chemicals. (RWR)

38717 Characteristics of generalized database management systems. Deutsch, D.; Fong, E. (National Bureau of Standards, Washington, DC). pp 27-49 of Generalized data management systems and scientific information. Paris; OECD Nuclear Energy Agency (1978).

From OECD/NEA working group on nuclear information; Berkeley, CA, USA (5 Oct 1977).

See CONF-771062—.

Generalized database management systems are complex and diverse software products that are used increasingly by organizations of all types. While many applications of database technology are highly successful, others do not meet expectations. An important determinant of success appears to be a close match between application requirements and database management system capabilities. This paper describes characteristics that differentiate database management software packages and presents in an appendix a list of software products and the computer systems on which they are available. 6 tables.

38718 Cost considerations for generalized database management systems. Deutsch, D.; Fong, E.; Collica, J. (National Bureau of Standards, Washington, DC). pp 50-91 of Generalized data management systems and scientific information. Paris; OECD Nuclear Energy Agency (1978).

From OECD/NEA working group on nuclear information; Berkeley, CA, USA (5 Oct 1977).

See CONF-771062—.

One important factor that must be considered when evaluating whether generalized database management software should be used is cost. A methodology and a framework based on the application life cycle for estimating costs associated with potential applications of these new software tools is proposed. Important classes of costs are identified and discussed. The problem of comparing costs for database-oriented versus traditional software systems is also considered. Finally, budget guidelines for estimating total life cycle costs for generated database management applications appear in an appendix. 6 figures, 2 tables.

38719 Structure of R and D information: some observations. Brooks, A.A. (Oak Ridge National Lab., TN). pp 93-105 of Generalized data management systems and scientific information. Paris; OECD Nuclear Energy Agency (1978).

From OECD/NEA working group on nuclear information; Berkeley, CA, USA (5 Oct 1977).

See CONF-771062—.

This paper is intended for the potential DBMS user who is not knowledgeable in the area of information and data structures. A simple pictorial but hopefully useful approach is taken which discusses the structure of information from the point of view of the user problem. These structures are then related to some simple considerations of data models. References to more advanced treatments are given. 9 figures.

38720 Overview of BDMS: the Berkeley Database Management System. Richards, D.R. pp 145-150 of Generalized data management systems and scientific information. Paris; OECD Nuclear Energy Agency (1978).

From OECD/NEA working group on nuclear information; Berkeley, CA, USA (5 Oct 1977).

See CONF-771062—.

The design and implementation of BDMS is outlined with emphasis on those features of particular importance to the management of complex scientific data having significant numerical content. These include binary internal representation of integer and single- or double-precision real data element types, ability to handle vector values of numeric data elements as well as arbitrary-length character and bit strings, and the provision of an extensive set of "hooks" for the attachment of user-supplied processing routines.

38721 Extensions to the Joshua GDMS to support environmental science and analysis data handling requirements. Suich, J.E.; Honeck, H.C. (E. I. du Pont de Nemours and Co., Aiken, SC). pp 151-159 of Generalized data management systems and scientific information. Paris; OECD Nuclear Energy Agency (1978).

From OECD/NEA working group on nuclear information; Berkeley, CA, USA (5 Oct 1977).

See CONF-771062—.

For the past ten years, a generalized data management system (GDMS) called JOSHUA has been in use at the Savannah River Laboratory. Originally designed and implemented to support nuclear reactor physics and safety computational applications, the system is now also supporting environmental science modeling and impact assessment. Extensions to the original system are being developed to meet new data handling requirements, which include more general owner—member record relationships occurring in geographically encoded data sets, unstructured (relational) inquiry capability, cartographic analysis and display, and offsite data exchange. This paper discusses the need for these capabilities, places them in perspective as generic scientific data management activities, and presents the planned context-free extensions to the basic JOSHUA GDMS. 4 figures.

38722 Status of data base management systems at Argonne National Laboratory. Fuja, P.M.; Lindeman, A.J. (Argonne National Lab., IL). pp 167-172 of Generalized data management systems and scientific information. Paris; OECD Nuclear Energy Agency (1978).

From OECD/NEA working group on nuclear information; Berkeley, CA, USA (5 Oct 1977).

See CONF-771062—.

Argonne National Laboratory has been using the System 2000 data base management system for the past two years. It has been

used for technical as well as administrative applications. This paper describes some of the experience gained relating to advantages and disadvantages of data base management systems as well as of System 2000 in particular.

38723 Use of TOTAL at the Netherlands Energy Research Foundation ECN. Rietveld, H.M. (Netherlands Energy Research Foundation, Petten). pp 227-231 of Generalized data management systems and scientific information. Paris; OECD Nuclear Energy Agency (1978).

From OECD/NEA working group on nuclear information; Berkeley, CA, USA (5 Oct 1977).

See CONF-771062—.

The general data base management system TOTAL is implemented on the CDC 6600 computer at the ECN research center. It is a network structure data base that provides a direct linkage between master and variable files. The structure of TOTAL is described first, and then its use in two widely different applications is explained. The first has to do with the automation of the routine transactions common in a library. The second is concerned with the computation of fuel burn-up in a nuclear reactor. Although the TOTAL system has some disadvantages, it is felt to be a "handsome" system to implement a data base. 2 figures. (RWR)

38724 SDI programs for small computers using the INIS database. Nevyjel, A. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Siebersdorf). pp 263-264 of Generalized data management systems and scientific information. Paris; OECD Nuclear Energy Agency (1978).

From OECD/NEA working group on nuclear information; Berkeley, CA, USA (5 Oct 1977).

See CONF-771062—.

Magnetic tapes received from INIS are used directly as the data base, even though this practice requires sequential scanning. Use of numbers corresponding to descriptors in a controlled thesaurus accelerates processing. The file organization is such as to facilitate processing of a large number of profiles against a rather small data base; thus, an SDI program is well suited. The monthly INIS tape contains about 6000 items. Profiles are formed as Boolean expressions of keywords. At present the monthly SDI service handles about 500 profiles for 130 users. It is planned to extend the information available to include some international data services such as RECON by terminal. (RWR)

38725 Scientific data handling, needs, and problems at the Zentralstelle fuer Atomkernenergie-Dokumentation (ZAED). Bau, W.; Behrens, H. (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt-am-Main). pp 265-267 of Generalized data management systems and scientific information. Paris; OECD Nuclear Energy Agency (1978).

From OECD/NEA working group on nuclear information; Berkeley, CA, USA (5 Oct 1977).

See CONF-771062—.

By law ZAED (with some similar agencies) is to grow into a specialized information center covering the fields of energy, physics, and mathematics. Its functions in this area are detailed; they include establishing a data information system, publishing data compilations, compiling a list of data compilations available thoughout the world, collecting and distributing existing data compilations for the Federal Republic, and coordinating activities in the compilation of physics data. Requirements for a physical data bank and guidelines for its construction are set forth. Compatibility problems are outlined, and the organization of a data bank is illustrated by one on superconductivity. (RWR)

38726 NEA Computer Program Library: a possible GDMS application. Schuler, W. (NEA Computer Program Library, Ispra, Italy). pp 276-287 of Generalized data management systems and scientific information. Paris; OECD Nuclear Energy Agency (1978).

From OECD/NEA working group on nuclear information; Berkeley, CA, USA (5 Oct 1977).

See CONF-771062—.

NEA Computer Program Library maintains a series of eleven sequential computer files, used for linked applications in managing computer codes for nuclear reactor calculations, storing index and program abstract information, and administering services to requesters. The high data redundancy between the files suggests that a data base approach would be valid. A possible "schema" for a CODASYL GDMS is suggested. 1 figure, 2 tables.

38727 Future directions in GDMS development and database conversion. Shoshani, A. (Lawrence Berkeley Lab., CA). pp 302-308 of Generalized data management systems and scientific information. Paris; OECD Nuclear Energy Agency (1978).

From OECD/NEA working group on nuclear information; Berkeley, CA, USA (5 Oct 1977).

See CONF-771062—.

The development of Data Management techniques has progressed significantly over the last 10 to 15 years. The main reason for the advances in this area is the tremendous improvement in hardware cost and performance. It became possible to store large amounts of data on random access devices (such as discs), and to afford the overhead of using generalized techniques in order to save special-purpose software development costs. In turn, the easier and more efficient was the process of accessing and maintaining data, the more data were collected and relied on for daily operations. The current stage of this process is that more and more users who are not computer specialists need to use computers for their data management needs, and the amounts of data needed to be managed are getting larger and larger. It is with this picture in mind that future development is presented. Hardware development trends for making data management a more efficient process, software development trends for making GDMSs more useful and easy to use by different types of users, distributed data bases to allow the distribution of data over a computer network, and data base conversion to provide software tools for moving data from one computer environment to another are discussed.

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In the Corporate Index, report literature is indexed using the name of the organization or institution responsible for issuing the report. Headings are provided for all report literature and for published literature for which a corporate approach is especially desirable, e.g., symposium and conference proceedings.

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DOE Energy Information Data Base: Corporate Author Entries (TID-4585) is used in the standardization of corporate entries. TID-4585 is available for purchase from the National Technical Information Service (NTIS), U. S. Department of Commerce, Springfield, Virginia 22161.

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The title may be supplemented with additional words, or a phrase, if it appears additional information would be helpful. In cases for which the title contains little or no information related to the subject entry, it may be replaced entirely by the supplementary information. A qualifier is not always required, and in such cases the title will follow the unqualified subject descriptor.

The descriptors selected for use as subject terms are generally the names of specific materials, things, or processes. To the extent possible, a qualifier is selected to describe the properties of, or processses applied to, the subject term.

Index entries are selected to indicate the important ideas and concepts presented in a document, rather than words that may appear in the text. Within the available thesaurus terms, the most probable or logical place to look for typical information is selected. "See references" are included to guide users from synonymous terms or phrases to the descriptor selected as a subject heading for the concept. (e.g. Pipeline Quality Gas see HIGH BTU GAS). "See also references" are used to indicate where to find references to subject concepts that are narrower, broader, or related to a particular subject heading. To complete an exhaustive search of a given subject, all such headings should be reviewed.

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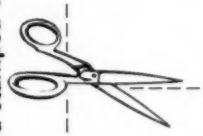

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Rome, Centro di Studi Nucleari della Casaccia

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Tokyo, National Diet Library
Tokai-Mura, Naka-gun, Ibaraki-ken, Japan Atomic Energy Research Institute

KOREA, REPUBLIC OF
Seoul, Atomic Energy Research Institute

MEXICO
Mexico, D. F., Comisión Nacional de Energía Nuclear

NETHERLANDS, THE
Petten, Reactor Centrum Nederland
The Hague, Bibliothek Octrooiraad

NORWAY
Kjeller, Institutt for Atomenergi

PORTUGAL
Sacavem, Junta de Energia Nuclear

SOUTH AFRICA, REPUBLIC OF
Pretoria, Atomic Energy Board Library

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Madrid, Junta de Energía Nuclear, Ciudad Universitaria

SWEDEN
Nyköping, Aktiebolaget Atomenergi Library

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Zürich, Swiss Federal Institute of Technology

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Boston Spa, Wetherby, Yorkshire, British Library Lending Division
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